THE

AMERICAN JOURNAL

OF

SCIENCE AND ARTS.

CONDUCTED BY

PROFESSORS B. SILLIMAN, B. SILLIMAN, JR.,

AND

JAMES D. DANA,

IN CONNECTION WITH

PROF. ASA GRAY, OF CAMBRIDGE,
PROF. LOUIS AGASSIZ, OF CAMBRIDGE,
DR. WOLCOTT GIBBS, OF NEW YORK.

SECOND SERIES.

VOL. XXVII.—MAY, 1859.

WITH A PLATE.

NEW HAVEN: EDITORS.
1859.

E. HAYES, PRINTER.

CONTENTS OF VOLUME XXVII.

NUMBER LXXIX.

SCIENTIFIC INTELLIGENCE.

NUMBER LXXX.

SCIENTIFIC INTELLIGENCE.

NUMBER LXXXI.

SCIENTIFIC INTELLIGENCE.

ERRATUM.

Vol. XXVI, p. 305, in the title to Dr. Hayes's article, dele "with a map."

ADDENDUM.

To bottom of page 243, after "Delphi Slate" add "or Black Lingula shale, equivalent of the Genesee Slate or Marcellus shale of New York."

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[SECOND SERIES.]

ART. I.—*Some Principles of Animal Psychology;* by D. F. WEINLAND.

Read before the American Association, at the Baltimore Meeting, May, 1858.

THE true difference between plants and animals consists in this, that animals have a consciousness of an outer world, while plants have none.

We are accustomed to distinguish animals from plants by their being endowed with free, that is, voluntary locomotion, and with feeling. Linnæus long since said: Saxa crescunt, Vegetabilia crescunt et vivunt, Animalia crescunt vivunt et sentiunt. A certain kind of feeling however cannot be denied to some plants, for instance to the Mimosa. As to the "voluntary" motion, which modern handbooks generally consider as the standard difference between plants and animals, I shall try to show that the term voluntary is far better replaced by the term "conscious of an outer world." What is it that strikes the microscopist as vegetable-nature in the Navicula, and as animal-nature in the Monas? Both move, but the Navicula in its steady onward course runs foul of every obstacle that crosses its way, while the Monas dodging with ease and dexterity, finds its winding way through a host of obstacles, apparently without touching one. It is this evident consciousness of surrounding objects that characterizes the animal.

The consciousness of an outer world is the fundamental principle of the soul of animals. The consciousness of self, of the Ego,

which is rather obscure, even in the highest animals, as it is also in the human child, is proportionate to the consciousness of an outer world; it is a result of the latter, for it is only in opposition to an outer world, that the animal conceives itself and becomes conscious of itself. The degree of psychical development in different kinds of animals may be judged from the degree of development of the consciousness of an outer world. The soul of an animal is the higher, the more relations it has to the outer world, that is, the larger the horizon of its outer world. The latter point I will explain with some illustrations taken from the lower animals, in which the psychical life is more simple, and therefore easier to understand.

What is the outer world of a coral-polyp? With hundreds of its kind it lives on the same coral-stock; it is there fixed and is able to move its mouth and tentacles only; thus it awaits its prey, a little craw-fish, without eyes, and without touching it—by a sense unknown to us—it perceives the presence of its prey, throws out its lasso-cells and catches it. Every individual has both the sexes united. Though closely crowded together, I never could notice a trace of psychical relation between the polyps of the same stock. What is the outer world of such a polyp? The whole range of its psychical life is evidently confined to the objects of food.

Let us now rise one step higher, to a Helminth, an Ascaris, that inhabits the intestine of some vertebrate. In regard to feeding it stands evidently on the same, perhaps on a lower level than the polyp, but still we must rank it psychically higher! The sexes are divided, and in the line of reproduction the male and the female individuals meet each other. There is therefore besides a consciousness of an outer world in regard to food, evidently also, a consciousness of other living individuals, although that consciousness may be dark enough.

We may take a bee, a wasp, or any of the social Hymenoptera, as a third step. In the bee the consciousness of the existence and the interest in other living individuals is not confined merely to the season and to the instinct of reproduction, but to the whole life. At any time the individuals of the bee-hive know each other, give each other signs, help each other, fight for each other. It is evident how much more varied the relations to the outer world, how much more extensive the latter is for a bee than for an Ascaris, and still more than for a polyp.

In order to judge how extensive the outer world is, of which an animal is conscious, that is, in order to judge about its psychical horizon, we must investigate the organs of that consciousness, that is, the psychical organs of animals.

The psychical organs of animals are of three kinds: (1.) **Receptive** *organs, organs which receive impressions from the outer*

world; here belongs the whole skin-system including the senses. (2.) REFLECTIVE *organs, that is, organs which combine the impressions received by the receptive organs; here belongs the central nervous system.* (3.) REACTIVE *organs, that is, organs which react upon the outer world; they are the servants of the central nervous system, which go from within outward, while the receptive organs go from without inward. These reactive organs consist in the whole system of voluntary muscles, with the bones which belong to them.*

The student of animal psychology has mainly to depend upon the third kind of organs, namely, the reactive, not only because the functions of the receptive and reflective organs are more or less hidden, but also because their functions are in fact the mirror of the whole psychical life of the animal, being also the resultants of the functions of the receptive and reflective organs.

The functions of the reactive organs are the voluntary motions. When observing these motions in an animal more closely, we soon perceive two kinds of motions, which are in their ends entirely different.

Let us look at a dog. We see in the first place, that it makes many motions, which have no other purpose than to satisfy the Ego of the dog itself. Such are the motions by which it eats, drinks, etc. These motions we call subjective, as having reference exclusively to the Ego, to the subject of the dog itself. But besides these, we see other motions in the dog, which have no immediate reference to the Ego of the dog, but to other dogs, or to men; we see motions of the head, the eyelids, the tail, of the whole body, by which the dog would show to other dogs or to his master, what it thinks, feels or wants. This second kind of motions I propose to call sympathetic motions.

The subjective motions are common to all animals and must be so. We have seen them in the polyp, and we see them in man. They are, generally speaking, the same throughout the animal kingdom. But the greatest diversity exists in regard to the sympathetic motions with different animals, and it will be evident from the following illustration, that the degree of their development is the principal standard for the student of animal psychology. The more the organs for sympathetic motions are developed, the more extensive is the outer world of which the animal is conscious, and the larger is its psychical horizon. Let us compare a fish, a lizard, a monkey and finally man in regard to the organs for sympathetic motions. The fish lying horizontally in the water, its head, neck, trunk and tail forming one continuous massy body; its eyes cold and stiff, turned sidewards, nearly immovable; no voice; hardly traces of an ear,—what organs has this animal to show to its fellow-creatures the processes of its soul? How different a spectacle offers a lizard to the thinking observer! Its body raised upon four legs; a dis-

tinct neck, upon which the head plays freely, thus giving at once to the eyes a horizon not only towards the sides but also upwards and downwards. And how expressive are those eyes! their expression mainly lies in the play of the eyelids, (of which the fish is destitute,) so that from the eyelids alone an experienced observer will perceive, whether the lizard is contented, or sad, or enraged. The tongue, which in the fish is a mere organ for swallowing food, is in the lizard a true organ of sympathetic motions, for we often can see them licking at each other in play or in love. The ear is well developed; they like music and some of them have a voice, as those well know who have spent a night in a virgin forest of the tropics. I will not dwell upon the intermediate degrees of psychical organization as exhibited in birds and the lower mammalia, but consider next the monkey. How rich at once the organization for sympathetic motions. The front legs—in the lizard mere locomotory organs—are in the monkey arms with which the mother embraces the young. The foot, a mere organ of support in the lizard, has become a hand, with which he grasps the hand of his mate. The lips, of which there is no trace in the lizard, are in the monkey very perfect organs of sympathetic motions. With the lips and the whole play of the muscles of the face, with the eyelids, with the tongue, with sounds, etc., the monkey shows to his fellow creatures what it likes and what it hates, what it wants and what it thinks.

Finally let us consider man. The natural position of the monkey is on four legs; in consequence, his head is naturally half bent downwards, thus confining the horizon of his eyes, and his front legs though used as arms are at the same time still organs of locomotion, mainly of climbing. On the contrary, man standing upright on his legs has his arms and hands free, they are perfect organs of sympathetic motions, locomotion being confined to the lower extremities. His head stands free upon the neck, thus giving to all the senses and particularly to the eyes the largest possible horizon. His eye is the mirror of his soul in which the fellow-man reads the innermost thoughts and feelings. His lips, tongue, and the whole apparatus of the larynx produce by their motion the most perfect of all sympathetic motions, language. These and many more not less interesting points are suggested by a comparison of the organs for sympathetic motions, and from the facts principles of practical importance for educational purposes may be derived; but what I have mentioned is sufficient illustration of the truth that owing to the great perfection of organs for sympathetic motions, the relations of man to his fellow beings are far the most diversified and at the same time the most intimate, not only to his fellow beings but to the outer world generally. Whatever our civilization has performed, has been done by improving these natural pyschical

organs. The outer world of the polyp is confined to the objects of its prey, the outer world of the civilized man is the Universe. Our steam vehicles on land and on sea, what else are they than improved organs of locomotion; our letters, our books, our journals, our telegraphs, what else are they than organs of human language on a more extended scale? our telescopes, our microscopes, what else are they than the receptive sense of the eye extended. Thus all the inventions of our civilization tend to enlarge the horizon of the individual man. And this is the true destiny of man. I do not know of a greater motto or life-principle than that which was written on the temple of the oracle of Delphi in ancient Greece: Γνῶθι σεαυτόν—"Know thyself;" but another is equally great, written by Wilhelm von Humboldt, the great philologist, (brother of the author of the Cosmos), it is this: "I wish to leave when dying as little as possible behind me in this world, with what I have not come in contact," that is what I have not mastered with my mind. Humboldt wanted the most perfect knowledge of the outer world, while the Greek philosopher wanted the deepest knowledge of himself. One of these sentiments is only the reverse of the other, or rather it follows immediately from the other. The most thorough knowledge of the outside world involves the deepest insight into ourselves; just as in morals, he who loves his neighbor the truest is the happiest, and thus loves himself the truest.

Art. II.—*On some unusual modes of Gestation;* by Jeffries Wyman, M.D.

Communicated to the Boston Soc. of Natural History. (See Proceedings of the Society, Sept. 15, 1857.)

Among Batrachians the circumstances under which the young are developed, though less varied than in some of the other classes of vertebrates, still present a considerable range. By most species the eggs are deposited in the water either upon aquatic plants or on the bottoms; by others, as in *Salamandra erythronota*, they are laid in damp places under logs or stones; with some the evolution of the embryo commences a short time previous to the laying of the egg and is completed subsequently, while there are other species which are wholly viviparous.

The most remarkable deviations from the ordinary modes are to be found in those instances in which the eggs, after being laid, are again brought into a more or less intimate relation with the parent, as in the "Swamp toads" (*Pipa Americana*) of Guiana, where each ovum is developed in a sac by itself on the back of the female, in *Notodelphys* of Venezuela, where all the eggs are lodged in one large sac, also on the back, and is analogous to the

pouch of the Marsupials, and in *Alytes*, the "Obstetric toad" of Europe, where the eggs are wound in strings around the legs of the male who takes care of them until they hatch.

The species, the habits of which are noticed below, and which, in so far as I have been able to learn, have not attracted the attention of naturalists, adds another to the series just mentioned, though the relation of the fœtus to the parent becomes less intimate than in any of the preceding cases.

Hylodes lineatus (Dum. and Bib.) is very common in Dutch Guiana, and its peculiar habits are well known to the colonists. The first specimen with young which came to my notice had been preserved in alcohol, and was presented to me by Mr. G. O. Wacker, residing at Osembo, on the Para Creek, Surinam, and had been captured at some distance from the water. The young, ten or twelve in number, though separated from the parent, he assured me, when found, were attached to her back.

In the month of May, 1857, during an excursion to the country inhabited by the Bush negroes, above Sara Creek on the upper Surinam River, I had an opportunity for the first time of seeing these animals carrying their young. The grass and bushes were quite wet from a recent fall of rain, and this seemed the inducement that led them from their hiding places, for when the ground was dry none had been seen. They were very quick in their movements, and when alarmed went at once into the grass and thick bushes. One of my companions, Mr. John Green, and myself succeeded in capturing some specimens, which, as we were just leaving the village, were placed at once in alcohol. In one instance the larvæ were retained permanently adherent to the back of the parent, in consequence of the coagulation of the mucus covering the surface of the body, and are still preserved in the Museum of Comparative Anatomy at Cambridge. (Fig. 1.) The young, from twelve to twenty in number, were collected upon the back of the mother, their heads directed towards the middle line. They were about three-fourths of an inch in length. No limbs were developed, though in some of them the rudiments of a leg existed in the form of a small papilla on either side of the base of the tail. No especial organ was found to aid them in adhering to the back of the parent. The adhesion may have been effected by the mouth; this is rendered probable by the fact that all of them had the mouth in contact either with the skin of the parent or with that of another larva. A viscid mucus covering the integuments undoubtedly assisted in some measure to bring about the same results. However this may be, they retained their places perfectly well, and were not displaced when the mother, closely pursued, carried them through the grass.

On dissection of the young nothing was found materially different to conditions of the larvæ of other Anoura. The external

gills had disappeared, but were replaced by internal ones which were arranged as usual on three hyoid arches. The development of the lungs had commenced and these were represented by a slender conical mass of cells, but not permeable to air. The mouth was provided with finely denticulated horny jaws, and the intestinal canal was shorter and less spirally convoluted than in ordinary larvæ of frogs and toads. The stomach was not so much developed as to be distinguished from the rest of the intestine; but this last, after passing the liver, was somewhat dilated, and contained, as was shown by the microscope, large quantities of yolk cells which had not been absorbed and which were adherent to its walls.

We have here then a larva, in all of the details of its structure, especially in the existence of gills and of a flattened tail, adapted to aquatic locomotion and respiration, yet passing a portion of its time at least on the back of its parent and at a distance from the water.

I was not able to ascertain whether the eggs were primarily deposited in the water or not, but it is well known to some of the colonists that after the larvæ have reached a certain degree of development they are carried about in the manner just described and they do not know them under any other circumstances. The existence of yolk cells in the intestine, shows that for a period at least they may have from these a supply of nutriment. But after this is exhausted, and it appeared to be nearly so in those which I have dissected, how do they obtain their food? In the absence of limbs adapted to terrestrial locomotion can they leave the body of the parent? and if they cannot, do they, as in the case of Pipa and probably in Notodelphys, depend upon a secretion from her?

Among Fishes, as far as at present known, the external conditions under which the eggs are developed are more varied than in any other class of Vertebrates. There are scarce any known conditions of the higher classes to which there are not analogies at least in the class of fishes. Besides the ordinary mode of depositing eggs upon the bottoms, some of the Salmonidæ, like the turtles, bury their eggs, the Lampreys (*Petromyzon*), the Breams, (*Pomotis*), the Hassars (*Callicthys*), the Stickle-backs (*Gasterostei*), &c., build more or less complete nests. Among some of the Pipe fishes, (*Syngnathidæ*), the eggs and subsequently the young, are carried in a pouch analogous to that of the opossums and other marsupial animals, and among some of the Sharks there is a vitelline placenta analogous to the Allantoidian one of the Mammalia.*

* Prof. Owen (in Philos. Transactions, 1834,) has pointed out the vascular relations of the fœtal Kangaroo to the parent. The chorion is not vascular, but the umbilical vesicle is largely provided with blood vessels, and, as far as his investigations go,

Fig. 1.—Hylodes lineatus.

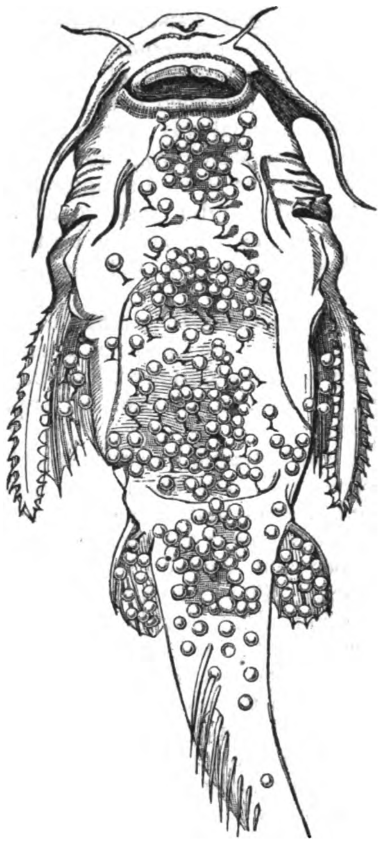


Fig. 2.—Aspredo lævis.

Fig. 4.—Pedicle showing capillary plexus, enlarged ten diameters.

Fig. 3.—Pedicle with an egg attached, enlarged 4 diameters.

To those species enumerated above where the eggs become more or less intimately connected with the body of the parent after they are laid may be added the Aspredos and some species of Bagrus, from Guiana.

Aspredo lævis (Cuv. and Val.), the "Trompetti" of the colonists, is about fifteen inches in length, and belongs to a remarkable genus of Siluroid fishes, which, in addition to several peculiarities of anatomical structure, are remarkable for carrying the eggs and young attached to the under surface of the body. These fishes are very abundant in the waters of the Surinam where they are taken in the nets with other kinds. They are not used as articles of food except by the negroes, who have a fancy for Siluroids generally, and in consequence these are known among the colonists as *Ningré fisi* or "nigger fish." A general account of the internal structure of Aspredo, is given in the Hist. Nat. des Poissons, by Cuvier and Valenciennes, T. xv, p. 35.

In describing the organs of reproduction, Valenciennes says: "the ovaries are small and contain very large eggs, which leads to the belief that this fish is viviparous." In those specimens which I have dissected the eggs when mature are not remarkable for their very great size, being from 0·09 to 0·11 inch in diameter, even after the commencement of the development of the fœtus, and when the egg has already increased in size. The ovaries are about an inch and a half long and completely separated from each other.

Valenciennes further describes certain appendages to the under side of the body: "A certain number of individuals in each species (of Aspredo) are remarkable for singular appendages on the under side of the thorax and abdomen, and which, after the few observations which I have been able to make appear to indicate a certain state of the female. I have not seen them in the males and the females do not have them at all times. They first appear as pores on the under and naked surface of the trunk; and these enlarge and swell into tubercles, which subsequently elongate into filaments, and the extremity of each filament is dilated into a small cupule." *

"It was in this state that Bloch saw them in an individual with six cirrhi, and, taking them for specific characters, named the fish *Platystacus cotylophorus*. But I have seen the same appendages in three species. Artedi, in the text of Seba, had

affords the principal vascular surface by means of which an interchange takes place between the fœtus and the parent. The vitelline circulation then, as in sharks, is the respiratory circulation. The allantois of the Marsupials appears to remain in a rudimentary condition, and does not form a connection with the parent. Thus the vascular relation of the fœtus of some of the sharks, as Carcharias, with the parent is identical with that of the Marsupials.

* Cuvier and Valenciennes, Hist. Nat. des Poissons. T. xv, p. 430.

already described two species, to which we now add a third. All three live in the waters of Guiana and this is all we know of their habits." *

From the preceding paragraphs it does not appear that Valenciennes had supposed that the so-called "cupules" were intended to contain or had contained ova, especially as he had previously expressed the belief that the Aspredos, in consequence of the large size of the eggs, were viviparous. The true use of the appendages in question relates to the development of the eggs, as the following description will show. The habits of the fish are well known to the fishermen, from one of whom Mr. Green obtained information with regard to their peculiar mode of gestation. After many ineffectual efforts, we at last succeeded in procuring the specimens on which the following observations were made, and Mr. Green has kindly presented to me some very fine ones from his own collection, without which this notice would have been much less complete. †

In the month of June the eggs are found adhering to the underside of the body, to the ventral and pectoral fins, and extend as far forward as the under lip, and as far backwards as the middle of the tail. (Fig. 2.) In some, however, the distribution is much more limited. I was unable to learn anything with regard to the transfer of the ova from the genital orifice to the point of their attachment. The only organ which seems in any way adapted to such a purpose is the slender and flexible tail terminated by a delicate caudal fin. It is possible that the eggs may be deposited on the bottom of the river, and subsequently attached by pressing the under side of the body upon them.

In those individuals where the ova were still in the ovary, but approaching maturity, the integuments of the under side of the body gave no other indications of the changes about to take place than of being quite vascular; the skin was perfectly smooth, no "pores" were visible, but a large vessel was seen emerging from the region of the liver, and descending along the median line gave off branches quite freely to the integuments. This may have some relation to the future development of the pedicles which support the eggs and perhaps to the nutrition of the embryo as will be adverted to hereafter.

In all the specimens which I have had an opportunity of examining, the eggs were either somewhat advanced or quite mature; so that no observations could be made on the earlier conditions of the egg and the formation of its pedicle. The pedicle is a flexible outgrowth from the common integuments, is about two lines in length, is attached to the skin by a slightly expanded base, and spreads out at its summit into a shallow cup

* Cuvier and Valenciennes, Hist. Nat. des Poissons. T. xv, p. 430.

† See an account of the habits of the Aspredo by Mr. Green in the Proceedings of the Boston Soc. of Nat. History for April, 1858.

or "cupule," for the support of the egg. It is composed almost entirely of fibrous tissue, invested with a layer of tesselated epithelium. In some instances when the eggs were but little advanced, numerous fusiform cells were detected among the fibres. It is vascular, two or three vessels reaching to the cup, where they ramify and form a somewhat extended capillary plexus. (Figs. 3 and 4).

The eggs vary according to the degree of development from the 0·09 to 0·15 of an inch in diameter, and are covered with an external homogeneous membrane, containing minute punctiform depressions—within this is a second, of a brownish color and composed of epithelium. The embryos which were the most advanced and just ready to hatch, had not as yet completely absorbed the yolk, and were coiled up within the membranes, which in consequence of the irregularities of the mass formed by the embryo, had no longer a spherical form.

The eggs are retained in connection with the cup apparently by adhesion alone, for as soon as the fœtus escapes, the egg membranes become very easily detached from the pedicle, and this last as shown by some of the specimens undergoes absorption.

The relation of the embryo to the parent in this singular mode of gestation cannot be determined very accurately, but the vascular plexus in the cup, seems to be more than is necessary for the mere nutrition of the part. The egg increases in size during incubation, those ova in which development had but slightly advanced measuring from 0·09 to 0·11 of an inch in diameter, while those nearly mature measured from 0·14 to 0·15 of an inch. How this increase of size of the embryo over the original size of the egg is actually obtained I have no facts to show, but either of two suppositions are probable; it may be by absorption of materials from the water which surrounds it, or from the capillary plexus of the pedicles, and in this case in a manner analogous to that of Pipa.

Among the Siluroid fishes of Guiana there are several species, which at certain seasons of the year have their mouths and branchial cavities filled either with eggs or young, and as is believed for the purpose of incubation. My attention was first called to this singular habit by the late Dr. Francis W. Cragin, formerly U. S. Consul at Paramaribo, Surinam. In a letter dated August, 1854, he says, "the eggs you will receive are from another fish. The different fishermen have repeatedly assured me, that these eggs in their nearly mature state are carried in the mouths of the parent, till the young are relieved by the bursting of the sac. Do you either know or believe this to be so, and if possible, where are the eggs conceived and how do they get into the mouth?"

In the month of April, 1857, on visiting the market of Paramaribo, I found that this statement, which at first seemed to be very improbable, was correct as to the existence of eggs in the mouths of several species of fish. In a tray of fish which a negro woman offered for sale, I found the mouths of several filled with either eggs or young, and subsequently an abundance of opportunities occurred for repeating the observation. The kinds most commonly known to the colonists, especially to the negroes, are *Jara-bakka*, *Njinge-njinge*, *Koepra*, *Makrede* and one or two others, all belonging either to the genus Bagrus or one nearly allied to it. The first two are quite common in the market and I have seen many specimens of them; for the last two I have the authority of negro fishermen but have never seen them myself. The eggs in my collection are of three different sizes, indicating so many species; one of the three having been brought to me without the fish from which they were taken.

The eggs become quite large before they leave the ovaries, and are arranged in three zones corresponding to three successive broods, and probably to be discharged in three successive years; the mature eggs of a Jara-bakka eighteen inches long, measure three fourths of an inch in diameter, those of the second zone one fourth; and those of the third or very minute, about one sixteenth of an inch.

A careful examination of eight specimens of Njinge-njinge about nine inches long, gave the following results:

The eggs in all instances were carried in the mouths of the males. This protection, or gestation of the eggs by the males, corresponds with what has been long noticed with regard to other fishes, as for example, Syngnathus where the marsupial pouch for the eggs or young is found in the males only, and Gasterosteus where the male constructs the nest and protects the eggs during incubation, from the voracity of the females.

In some individuals the eggs had been recently laid, in others they were hatched, and the fœtus had grown at the expense of some other food than that derived from the yolk, as this last was not proportionally diminished in size, and the fœtus weighed more than the undeveloped egg. The number of eggs contained in the mouth was between twenty and thirty. The mouth and branchial cavity were very much distended, rounding out and distorting the whole hyoid and branchiostegal region. Some of the eggs even partially protruded from the mouth.

The ova were not bruised or torn as if they had been bitten, or forciby held by the teeth. In many instances the fœtuses were still alive, though the parent had been dead for many hours.

No young or eggs were found in the stomach, although the mouth was crammed to its fullest capacity.

The above observations apply to Njinge-njinge. With regard to Jarra-bakka, I had but few opportunities for dissection, but in several instances the same conditions of the eggs were noticed as stated above; and in one instance, besides some nearly mature fœtuses contained in the mouth, two or three were squeezed apparently from the stomach; but not bearing any marks of violence or of the action of the gastric fluid. It is probable that these found their way into that last cavity after death, in consequence of the relaxation of the sphincter which separates the cavities of the mouth and the stomach. These facts lead to the conclusion that this is a mouth gestation, as the eggs are found there in all stages of development, and even for some time after they are hatched.

The question will be very naturally asked, how under such circumstances, these fishes are able to secure and swallow their food. I have made no observations bearing upon such a question. Unless the food consists of very minute particles, it would seem necessary that during the time of feeding the eggs should be disgorged. If this supposition be correct, it would give a very probable explanation of the only fact which might be considered at variance with the conclusion stated above, viz., that we have in these fishes a mouth gestation. In the mass of eggs with which the mouth is filled, I have occasionally found the eggs, rarely more than one or two, of another species. The only way in which their presence may be accounted for, it seems to me, is by the supposition that while feeding, the eggs are disgorged, and as these fishes are gregarious in their habits, when the ova are recovered, the stray egg of another species may be introduced into the mouth among those which naturally belong there.

5.

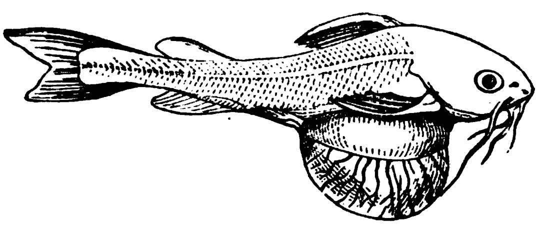


Fig. 5 represents a nearly mature fœtus of the natural size from the mouth of Bagrus, with the yolk sac partially included in the cavity of the abdomen.

ART. III.—*Some Facts respecting the Nitrates;* by JOHN M. ORDWAY.

WHILE studying the nitrates of the sesquioxyds I found it advisable, for the sake of comparison, to examine the proto-nitrates also, with reference to some points not generally taken into account in enumerating the properties of these salts. And as the nitrates are among the most common and important salts, it may be worth the while to exhibit these gleanings in fields often gone over but not yet entirely cleared. There are few new facts to be brought forward, but the chief object of this paper is to show the fitness of certain means for the illustration of some general truths already well known.

In most chemical text-books no good instances are given of the development of heat by mere solidification. It is indeed usually mentioned that water may be cooled many degrees below the freezing point and remain liquid, and that on congealing its temperature suddenly rises to 32° F. But the experiment is so troublesome to make, especially in the lecture room, that these truths commonly pass as matters of faith rather than of sight, and the important principles which they illustrate, often fail of being distinctly impressed on the mind of the student. Now many of the hydrated salts, and among them the nitrates, melt at points above the common temperature of the air, and are therefore well adapted for showing, at all seasons and with great ease and clearness, the inertia of bodies with regard to change of form and the liberation of sensible heat by crystallization.* Nitrate of lime is preëminently suitable for the exhibition of these properties, since after having been fused and heated above 150° F., it may be cooled in a glass vessel as low as 60°, and kept in the liquid state a long time, often for several days; but on dropping in a bit of the solid nitrate, crystallization immediately commences, and an inserted thermometer soon rises to 110° F.

A substance which may be had both liquid and solid at a temperature considerably below the melting point, is obviously very convenient for displaying the comparative densities and specific heats in the two forms, as complications caused by differences of temperature, may be entirely avoided. Thus the specific gravity of a specimen of nitrate of lime in the liquid state, at 60° F., was found to be 1·79. Some of the same was poured into oil of turpentine, made to solidify, and cooled to

* In an excellent work published in 1857,—"Lehrbuch der physikalischen und theoretischen Chemie, von H. Buff, H. Kopp und F. Zamminer,"—hyposulphite of soda is mentioned as capable of affording a very striking example of the heat becoming free during fixation; but this salt is less easy to prepare than most of the nitrates.

60° F. Its density was now 1·90. The contraction may be rendered appreciable by the eye, if we cool to a certain degree some melted nitrate contained in a long necked flask, fill with an oil up to a marked height, effect the crystallization, and then cool to the same point as before.

To illustrate the absorption of heat during the liquefaction of solids, freezing mixtures are commonly employed in which one of the ingredients, ice, is already cold. The experiment is more striking when all the articles used are at the temperature of the surrounding air. Such may be the case if we take crystallized sulphate of soda and a sesquinitrate. A mixture of 36 grams of powdered pernitrate of iron crystals and 57 grams of fine Glauber's salt, liquefied and lowered thermometer from 65° F. to zero. It readily froze water contained in a test tube. In cold weather, 8 grams of the nitrate and 9·5 grams of the sulphate brought the thermometer from 22° to −10°.*

In manufacturing salts on a large scale, the hydrometer is a very useful and ready instrument for determining when a solution is of the right strength to crystallize. But the quantities operated on in the laboratory are generally so small that the hydrometer can hardly be made available. The bulb of a thermometer, however, requires but little depth of liquor, and hence to one who wishes to prepare in the small way any of the highly soluble salts, a knowledge of the boiling points of the desired products may be of great service. Thus, finding that crystallized protochlorid of tin melts at 107° F., boils at 251°, and may be cooled to 83° without becoming solid, we see that to make this article in midsummer the evaporation of the weak solution must be continued till the boiling point gets nearly or quite up to 251°.

It should be remarked that the melting and boiling points given below, do not pretend to absolute exactness. No two different lots of the same salt are likely to give just the same figures; for it is next to impossible to get most of the hydrated salts exactly dry,—neither effloresced nor retaining mother liquor in the interstices. For any particular specimen the point of fusion can be determined with great precision. But the boiling points are high and, unless very nice precautions are taken, there will be some loss of water in heating up. So to find the temperatures of incipient ebullition, crystals were taken that were not entirely dry to start with, and the correctness of the indications was judged of after ascertaining the solidifying points of the residues.

There is, of course, no definite limit to the cooling which a melted salt may undergo without beginning to crystallize. I

* Nitrate of iron is pretty corrosive, and should not be touched with the fingers.

have here put down the lowest point at which each of the salts tried has actually been observed to remain liquid without any special precautions being taken to retard the crystallization. With some few of the nitrates it makes a difference in this respect whether they are moderately or strongly heated. If any one of them is heated but little more than is necessary to effect its fusion, it will begin to solidify before it gets many degrees below the melting point. But when the nitrates of lime, iron and chrome are brought nearly up to the boiling point, they can be cooled very low before they begin to shoot. Considering the difference in color between the solid and the liquid nitrates of iron, chrome and cobalt, there seems to be no special absurdity in supposing that some strongly heated nitrates may have to overcome a reluctance to change of state as well as one to change of form, and are therefore slower in beginning to show crystals.

The composition has in each instance been determined anew, either by simple ignition or by drying down with an excess of sulphuric acid, and so there is little room for error. It appears that a greater uniformity prevails among the nitrates than among any other salts. In all but four of those examined there are either six or three equivalents of water to each equivalent of nitric acid. In only two cases, has the same base been found capable of forming two different crystallized nitrates.

SEXHYDRATES.

Nitrate of Magnesia, $\dot{M}g\ddot{\overline{N}}\dot{\overline{H}}_6$.—This salt melts at 194° F. The liquid has been cooled to 188°. It boils at 290°.

When the heating is continued, the salt remains liquid and clear till about five equivalents of water and a little of the acid are expelled. The residue is not entirely soluble. It becomes hot in recombining with water.

Nitrate of Zinc, $\dot{Z}n\ddot{\overline{N}}\dot{\overline{H}}_6$.—Melts at 97½° F. It has been cooled in the liquid form to 87°. It boils at 268°.

Some of the melted crystals, on continued boiling, remained thin and clear till 42 p. c. of the weight was gone. The residue hardened to a vitreous mass on cooling, which had a composition not far from $\dot{Z}n_4\ddot{\overline{N}}_3\dot{\overline{H}}_3$. This substance did not heat much when treated with water; but when some crystals were boiled till about four equivalents of water passed off, the residue evolved considerable heat in recombining with water.

Nitrate of zinc cannot be heated long without becoming basic and partially insoluble in water.

Nitrate of Manganese, $\dot{M}n\ddot{\overline{N}}\dot{\overline{H}}_6$.—Melts at 78½° F. Some dry crystals liquefied in a stoppered bottle during the hot weather of June and remained melted till September, though the temperature was sometimes as low as 60°. It boils at 265°.

If the boiling is continued, decomposition soon commences and black oxyd of manganese is precipitated. This gradual formation of peroxyd is also effected by a long continued steam heat.

Some liquid nitrate at 70° F. was found to have a density of 1·8104, while the solid salt at 70° had the specific gravity 1·8199.

Nitrate of Nickel, Ñi.N̈.Ḧ₆.—Melts at 134° F. The liquid has been cooled to 115°. It boils at 278°.

When the boiling is continued the liquid remains clear till three equivalents of water are expelled. It then begins to thicken and parts with acid.

Nitrate of Cobalt, Ċo.N̈.Ḧ₆.—I had too little of this to determine accurately the melting and boiling points, but they differ little from those of the nickel salt.

Pernitrate of Iron, F̶e + 3N̈Ḧ₆.—Melts at 117° F. May remain liquid at 70°, after being strongly heated. It boils at 257° F.

The specific gravity of some in the liquid state at 70° F., was found to be 1·6712, while the same solidified and cooled to 70°, had a density of 1·6835.

Nitrate of Chrome, C̶r + 3N̈Ḧ₆.—This salt melts at about 98° F. It has been cooled to 68°. It boils at 258°.

Nitrate of Alumina, A̶l + 3N̈Ḧ₆.—Melts at 163° F., can be cooled to 147½°, and boils at 273°.

Nitrate of Uranium, ŪN̈Ḧ₆.—This beautiful salt melts at 139°. It may remain liquid at 115°. It begins to boil at 245°.

When the boiling was continued, the stuff remained thin and clear till about four equivalents of water and a little of the acid passed off. The residue gave with water a solution which was turbid at first but soon became clear. Some heat was evolved during the solution.

Nitrate of Copper.—When nitrate of copper crystallizes at a low temperature, it forms a pale blue salt having the composition ĊuN̈Ḧ₆. These crystals are not permanent in hot weather, for at 79½° F. they break up into a liquid and crystals of the trihydrate. To make the whole liquid requires a heat above 100° F., and so the pale crystals have no definite solidifying point.*

TRIHYDRATES.

Nitrate of Copper, ĊuN̈Ḧ₃.—This is the formula of the crystals which form above 79½° F. They have nearly the same shape as the sexhydrate sometimes assumes, but are deep blue and are permanent in every state of the air. The composition is erroneously given in some books as ĊuN̈Ḧ₄,—probably because the analysts took no pains to ascertain the dividing limit between the two salts, and tried a mixture.

* A solution of nitrate of copper is sometimes sold, standing at 55° B. As a solution saturated at 50° F. has just this strength, it is not strange that the maker often finds his returned carboys broken by huge masses of pale crystals.

The trihydrate melts at 238°. It has been cooled down to 224° before beginning to shoot. It boils at 338°.

If the boiling is continued, nitric acid immediately begins to pass off, and a green basic nitrate is deposited.

Nitrate of Lanthanum, $\dot{L}a\,\ddot{N}\,\dot{H}_3$.—This was found to melt at 104° F., and was cooled to 70° without crystallizing immediately. It boiled at 258°. These figures, however, cannot be considered as exact, for the salt used for trial amounted to but 32 grams, and was not absolutely free from didymium and cerium.

Nitrate of Glucina, $\bar{B}e + 3\,\ddot{N}\,\dot{H}_3$.—Melts at 140° F. and may be cooled as low as 85° before it begins to fix. It boils at 285°.

Some boiled till the thermometer rose to 320°, gave off acid, but remained perfectly clear. When this residue was cooled to 61°, a crystal did not cause it to solidify, because it was too basic. But the addition of strong nitric acid, induced a rapid crystallization, the temperature rising to 142°.

When the salt was boiled not quite so long, the product could be made to solidify, but the resulting temperature was considerably lower. Dilution with a basic salt, has therefore the same effect on the melting point as dilution with water.

TETRAHYDRATES.

Nitrate of Strontia, $\dot{S}r\,\ddot{N}\,\dot{H}_4$.—Unlike any other hydrated nitrate, this salt crystallizes in the monometric system.

The composition of hydrated nitrate of strontia is always laid down in the books as $\dot{S}r\,\ddot{N}\,\dot{H}_5$. But this formula has no analogy in its favor, and having repeatedly tried good crystals formed at a low temperature I have invariably found but four equivalents of water. The nitrate crystallized above 75° F., is generally anhydrous, and that formed below 60° is hydrated, but between these temperatures there is no certainty. Thus a solution saturated at 84° F., while cooling down to 62°, deposited nothing but anhydrous crystals; and a solution saturated at 71°, by standing some hours where the thermometer did not get below 70°, gave only fully hydrated crystals.

The hydrated salt is resolved by heat into a liquid and the anhydrous nitrate. Even the hot weather of summer causes it to sweat, if kept in a close vessel. In dry air, it loses all its water by efflorescence.

Nitrate of Lime, $\dot{C}a\,\ddot{N}\,\dot{H}_4$.—Melts at 111° F. Some that was heated only to 124°, began to crystallize when it had cooled to 96°. After being heated to 153°, it remained liquid over night and got down to 57½°. This salt boils at 270°. When the boiling is continued, the mass remains liquid and clear till about one third of the water passes off. Farther heating renders it anhydrous, with scarcely any loss of acid. This dry residue evolves a strong heat in recombining with water.

Nitrate of Cadmium, $\dot{C}d\,\ddot{N}\,\dot{H}_4$.—This salt melts at 139° F. It has been cooled to 91° before beginning to crystallize. It boils at about 270°. On continued boiling it continues clear and thin till nearly three equivalents of water are gone. When all the water has passed off, a small portion of the remaining dry mass is insoluble.

Nitrate of Bismuth, which was formerly supposed to be a trihydrate, has been found more recently to have the anomalous composition $\bar{B}i\,\ddot{N}_3\,\dot{H}_{10}$. In several trials of a pure nitrate dried over sulphuric acid, I have obtained, by ignition, 48 per cent of oxyd. This would make the quantity of water as near eleven as ten equivalents. It is barely possible then that nitrate of bismuth may be a combination of a trihydrate with a tetrahydrate and have for its true formula $\bar{B}i\,\ddot{N}_3\,\dot{H}_9 + \bar{B}i\,\ddot{N}_3\,\dot{H}_{12}$.

This salt is not deliquescent and does not effloresce, even when kept for a long time over sulphuric acid. It is insoluble, as a whole, in water, and does not melt clear. At 163½° F., it resolves itself into a clear liquid and one opaque solid. The mixture has been cooled to 155°, but on stirring it solidified again while the temperature rose to 163½°. Some of the liquid part decanted clear, formed on cooling a mass of crystals quite wet with acid and having altogether a composition not far from $\bar{B}i_3\,\ddot{N}_{11}\,\dot{H}_{38} = 3\,\bar{B}i\,\ddot{N}_3\,\dot{H}_{10} + 2\,\ddot{N}\,\dot{H}_4$.

ART. IV.—*Further Observations on the Allotropic Modifications of Oxygen, and on the Compound Nature of Chlorine, Bromine, &c.*; by Professor SCHÖNBEIN.*

THESE last six months I have been rather busily working on oxygen, and flatter myself not to have quite in vain maltreated my favorite; for I think I can now prove the correctness of that old idea of mine, according to which there are two kinds or allotropic modifications of active oxygen, standing to each other in the relation of + to −, *i. e.* that there is a positively-active and a negatively-active oxygen,—an ozone and an ant-ozone, which on being brought together neutralize each other into common or inactive oxygen according to the equation $(+\overset{\circ}{O})+(-\overset{\circ}{O})=O$.

The space allotted to a letter being so small, I cannot enter into the details of my late researches, and must confine myself to some general statements, which I hope, however, will give a clear notion of the nature of my recent doings. A paper will

* Addressed as a letter to Prof. Faraday, and communicated by him to the L., E. and D. Phil. Mag., xvi, 178.

before long be published in the Transactions of the Academy of Munich.

Ozonized oxygen, as produced from common oxygen by the electrical spark or phosphorus, is identical with that contained in a number of oxy-compounds, the principal ones of which are the oxyds of the precious metals, the peroxyds of manganese, lead, cobalt, nickel and bismuth,—permanganic, chromic and vanadic acids; and even the peroxyds of iron and copper may be numbered among them.

The whole of the oxygen of the oxyds of the precious metals exists in the ozonic state, whilst in the rest of the oxy-compounds named, only part of their oxygen is in that condition. I call that oxygen negatively-active, or ozone *par excellence*, and give it the sign $-\overset{\circ}{O}$ on account of its electromotive bearing. Though generally disinclined to coin new terms, I think it convenient to denominate the whole class of the oxy-compounds containing $-\overset{\circ}{O}$ "ozonids." There is another less numerous series of oxy-compounds in which part of their oxygen exists in an opposite active state, *i. e.* as $+\overset{\circ}{O}$ or antozone, wherefore I have christened them "antozonids." This class is composed of the peroxyds of hydrogen, barium, strontium, and the rest of the alkaline metals; and on this occasion I must not omit to add, that what I have hitherto called ozonized oil of turpentine, ether, &c., contain their active oxygen in the $+\overset{\circ}{O}$ state, and belong therefore to the class of the "antozonids."

Now, on bringing together (under proper circumstances) any ozonid with any antozonid, reciprocal catalysis results, the $-\overset{\circ}{O}$ of the one and the $+\overset{\circ}{O}$ of the other neutralizing each other into O, which, as such, cannot be retained by the substances with which it had been previously associated in the $-\overset{\circ}{O}$ or $+\overset{\circ}{O}$ condition. The proximate cause of the mutual catalysis of so many oxy-compounds depends therefore upon the opposite states of the active oxygen contained in those compounds.

I will now give some details on the subject.

1. Free ozonized oxygen $=(-\overset{\circ}{O})$, and peroxyd of hydrogen $=HO+(+\overset{\circ}{O})$, or peroxyd of barium $=BaO+(+\overset{\circ}{O})$ (the latter suspended in water), on being shaken together destroy each other, $HO+(+\overset{\circ}{O})$ or $BaO+(+\overset{\circ}{O})$ being reduced to HO or BaO, and $+\overset{\circ}{O}$ and $-\overset{\circ}{O}$ transformed into O.

2. Aqueous permanganic acid $=Mn^2O^2+5(-\overset{\circ}{O})$, or a solution of permanganate of potash mixed with some dilute nitric acid is almost instantaneously discolored by peroxyd of hydrogen or

peroxyd of barium, the nitrate of the protoxyd of manganese being formed in the first case, and in the second, besides this salt, the nitrate of baryta. It is hardly necessary to state, that in bothc ases the $-\overset{\circ}{O}$ of the permanganic acid and the $+\overset{\circ}{O}$ of the peroxyd of hydrogen or barium are disengaged as O.

3. An aqueous solution of chromic acid containing some nitric or sulphuric acid and peroxyd of hydrogen are rapidly transformed into the nitrate or sulphate of oxyd of chromium, HO, and inactive oxygen, which is of course disengaged. A solution of chromic acid mixed with some nitric acid and BaO^2 gives a similar result, nitrate of baryta and oxyd of chromium being formed, and O disengaged.

4. If you add to a mixture of any peroxyd salt of iron and the red ferro-sesquicyanuret of potassium (both substances dissolved in water) some peroxyd of hydrogen, prussian blue will be thrown down and inactive oxygen set free. On introducing into a mixture of nitrate of peroxyd of iron and the ferro-sesquicyanuret of potassium the peroxyd of barium, a similar reaction takes place, prussian blue, nitrate of baryta, &c., being formed, and inactive oxygen eliminated. From these facts it appears that, under certain conditions, even peroxyd of iron and HO^2 or BaO^2 are capable of catalyzing each other into FeO and HO, or BaO and O.

5. Under certain circumstances PbO^2 or MnO^2 are soluble in strong acetic acid; now if you add to such a solution HO^2 or BaO^2, the peroxyds will be reduced to HO or BaO, and PbO or MnO, inactive oxygen being disengaged.

6. It is a well known fact that the oxyd of silver $=Ag(-\overset{\circ}{O})$, or the peroxyd of that metal $=Ag(-\overset{\circ}{O})^2$, and the peroxyd of hydrogen $=HO+(+\overset{\circ}{O})$, catalyze each other into metallic silver, water and inactive oxygen. Other ozonids such as $PbO+(-\overset{\circ}{O})$ or $MnO+(-\overset{\circ}{O})$, on being brought in contact with $HO+(+\overset{\circ}{O})$, are transformed into PbO or MnO, HO and O. Now the peroxyd of barium $=BaO+(+\overset{\circ}{O})$, acts like $HO+(+\overset{\circ}{O})$. If you pour water upon an intimate mixture of AgO, or AgO^2 and BaO^2, a lively disengagement of inactive oxygen will ensue, AgO, AgO^2 and BaO^2 being reduced to metallic silver and baryta. In concluding the first part of my letter, I must not omit to state the general fact, that the oxygen disengaged in all cases of reciprocal catalysis of oxy-compounds, behaves in every respect like inactive oxygen.

There is another set of chemical phenomena, in my opinion closely connected with the polar states of the active oxygen contained in the two opposite classes of peroxyds. It is known that

a certain number of oxy-compounds, for instance the peroxyds of manganese, lead, nickel, cobalt, bismuth, silver, and also permanganic, chromic, and vanadic acids, furnish with muriatic acid chlorine, whilst another set, such as the peroxyds of barium, strontium, potassium, &c., are not capable of eliminating chlorine either out of the said acid or any other chlorid. This second class of oxy-compounds produces, however, with muriatic acid, the peroxyd of hydrogen; and it is quite impossible in any way to obtain from the first class of the peroxyds HO^2, or from the second chlorine.

You are aware that, from reasons of analogy, I do not believe in the doctrine of chlorine, bromine, &c., being simple bodies, but consider those substances as oxy-compounds, analogous to the peroxyds of manganese, lead, &c., in other terms, as "ozonids." Chlorine is therefore to me the peroxyd of murium $=MuO+(-\overset{\circ}{O},)$ hydrochloric acid $=MuO+HO$, and, as already mentioned, the peroxyd of barium $=BaO+(+\overset{\circ}{O},)$ that of hydrogen $=HO+(+\overset{\circ}{O},)$ and the peroxyd of manganese $=MnO+(-\overset{\circ}{O})$. Proceeding from these suppositions, it is very easy to account for the different way in which the two sets of peroxyds are acted upon by muriatic acid.

From reasons as yet entirely unknown to us, HO can be chemically associated only with $+\overset{\circ}{O}$, and with no other modification of oxygen, to constitute what is called the peroxyd of hydrogen; and in a similar way MuO (the hypothetically anhydrous muriatic acid of older times) is capable of being united only to $-\overset{\circ}{O}$ to form the so-called chlorine, which I denominate peroxyd of murium. If we cause $MuO+HO$ to react upon $BaO+(+\overset{\circ}{O},)$ MuO unites with BaO, and HO with $+\overset{\circ}{O}$; but if you bring together $MuO+HO$ with $Mn+(-\overset{\circ}{O},)$ part of MuO is associated to MnO, another part to $-\overset{\circ}{O}$, water being eliminated, according to the equation

$$2(MuO, HO)+MnO+(-\overset{\circ}{O})=MuO, MnO+MuO, (-\overset{\circ}{O})+2HO.$$

As you will easily perceive, from these views it would follow that, under proper circumstances, two opposite peroxyds, on being intimately mixed together and in the right proportion and acted upon by muriatic acid, could yield neither chlorine nor peroxyd of hydrogen, but merely inactive oxygen. If somewhat dilute muriatic acid be poured upon an intimate mixture of five parts of peroxyd of barium and two parts of peroxyd of manganese, the whole will be rapidly transformed into the muriates of baryta and protoxyd of manganese, the active oxygen of both the peroxyds being disengaged in the inactive condition, and

not a trace of free chlorine making its appearance. The same result is obtained from dilute hydrobromic acid.

Another consequence of my hypothesis is this: that an intimate and correctly proportioned mixture of two opposite peroxyds, such as the peroxyd of barium and that of lead, on being acted upon by any oxy-acid, cannot produce the peroxyd of hydrogen; or, to express the same thing in other terms, muriatic acid must act upon the said mixture exactly in the same way as the oxy-acids do; and that is indeed the case. Mixtures of the peroxyds just mentioned and acetic or nitric acids, are readily converted into the acetates or nitrates of baryta and protoxyd of manganese, the active oxygen of both the peroxyds being of course disengaged in the inactive condition.

Before I close my long story I must mention one fact more, which, in my opinion, is certainly a very curious one. If you mix an aqueous and concentrated solution of bromine with a sufficient quantity of peroxyd of hydrogen, what happens? A very lively disengagement of inactive oxygen takes place, the color and the odor of the bromine solution disappear, the liquid becomes sour, and on adding some aqueous chlorine to it, bromine reappears. From hence we are allowed to conclude, that, on bringing bromine into contact with peroxyd of hydrogen, some so-called hydrobromic acid is produced. The hypothesis at present prevailing cannot account for the formation of that acid otherwise than by admitting that bromine takes up the hydrogen of HO^2, eliminating the two equivalents of oxygen united to H. I, of course, take another view of the case; bromine is to me an ozonid like peroxyd of lead, &c., *i. e.*, the peroxyd of bromium $=BrO+(-\mathring{O})$. Now $HO+(+\mathring{O})$ and $BrO+(-\mathring{O})$ catalyze each other into HO, BrO, and inactive oxygen, BrO+HO forming hydrobromic acid, or what might more properly be called hydrate of bromiatic acid.

It will be perceived that I am growing more and more hardened in my heretical notions, or, to speak more correctly, in my orthodox views; for it was Davy who acted the part of a heretic in overthrowing the old, venerable, true creed. Indeed the longer I compare the new and old doctrine on the nature of chlorine, &c., with the whole material of chemical facts bearing upon them, the less I am able to conceive how Davy could so lightly and slightly handle the heavy weight of analogies which, in my opinion, speak so very strongly and decisively in favor of Berthollet's views. There is no doubt Sir Humphrey was a man of great genius, and consequently very imaginative; but I am almost inclined to believe that, by a certain wantonness, or by dint of that transcendent faculty of his mind, he was seduced to conjure up a theory intended to be as much out of the way and "*invraisemblable*" as possible, and serve nevertheless certain

theoretical purposes; and certainly, if he entertained the intention of solving such a problem, he has wonderfully succeeded. But what I still more wonder at is both the sudden and general success which that far-fetched and strained hypothesis met with, and the tenacity with which the whole chemical world has been sticking to it ever since its imaginative author pleased to divulge it: and all this could happen in spite of the fact that the new doctrine, in removing from the field of chemistry a couple of hypothetical bodies, was, for analogy's sake, forced to introduce fictitious compounds, not by dozens only, but by hundreds,—the oxy-sulphion, oxy-nitrion, and the rest of those "nonentia." But enough of this subject, upon which I am apt to grow warm and even angry. Although the results I have obtained from my recent investigations cannot but induce me to begin another, and, I am afraid, endless series of researches, I shall for the present cut short the matter and indulge for some time in absolute idleness.

Bâsle, June 25th, 1858.

ART. V.—*Occurrence of Cobalt and Nickel in Gaston county, North Carolina;* by HENRY WURTZ, Prof. Chemistry, National Medical College, Washington.

Read in part before the American Association for the Advancement of Science at Baltimore, April, 1858. *

WHILE exploring a large tract of land in Gaston and Lincoln counties, N. C., during the summer of 1857, I found indications of the existence of ores of cobalt and nickel diffused throughout a considerable extent of country.

The region explored comprised a range of rocks composed of alternating strata of talcose and quartzose schists, which crosses the South fork of the Catawba river a little south of the line between Lincoln and Gaston counties, and in the immediate neighborhood of the falls known as the "High Shoals of the Catawba." The general direction of this range, which forms a well defined metalliferous belt of many miles in longitudinal extent, is about N. 20° E. (varying, however, in places between due N. and N. 35° E.), and at the High Shoals it is three or four miles wide. It is everywhere traversed by "veins" of quartz, carrying pyrites and other sulphids, and showing at the surface the limonite *gozzans* derived from their oxydation. These "veins" in some places have all varieties of strike and dip, although the most important ones were found most frequently to *conform in strike*

*** The proper date of this paper is August, 1857, at which time it was announced to be read at the Montreal meeting of the Association. Accidents beyond the author's control have delayed its appearance until now.**

(or very nearly so) with the containing rocks. The dip of these rocks is nearly vertical, usually a little westerly, although notable contortions and local variations of dip were observed in a few places. At the place where this metalliferous belt crosses the river its boundaries appear to be, on the northwest side a thickly bedded *granitoid* schist, and on the southeast side, forming the barrier over which the water falls at the High Shoals, a massive range of peculiar feldspathic rocks, also thickly bedded in structure, and characterized by having the feldspar crystals, which are numerous and large, all arranged with their longer diameters parallel to the bedded structure, or generally about N. 20° E. On the southwesterly prolongation of this latter rock, wherever it crosses any of the tributaries of the river, a waterfall is found. Crowder's mountain, which towers up about a dozen miles distant in a southwesterly direction, seems to lie on or near this range.

Proceeding to the northeastward from the High Shoals into Lincoln county along this belt of talcose and quartzose schists, many places are encountered where gold has been mined, or washed out from the beds of the small streams, among which may be mentioned the Shuford and Cansler Gold Mines.

Many miles in the distance, but apparently on the same range, is seen the high elevation in which is situated the iron mine known as the "Graham Ore Bank." Fragments of limonite gozzan and honey-combed quartz are constantly encountered on the surface, sometimes isolated, and sometimes strewed along for considerable distances marking outcrops. In this part of the range, the quartz veins are usually found to contain, wherever they have been opened, more or less *galena, blende* and *chalcopyrite*, usually with native gold. In one place *rutile* was found.

Going southwestwardly from the river we find the rocks presenting similar indications, and in the course of some fifteen miles, we encounter successively the "Long Creek Gold Mines," (from one of which, known as the Asbury Shaft, much gold has been taken); and a number of places where iron ore is or has been mined, known as the "Costner Ore Bank;" the "Alison Ore Bank;" the "Ormond Ore Bank;" the "Ferguson Ore Bank," and "Briggs' Ore Bank." A few miles beyond the latter, not far from the same range, lies the well known "Kings Mountain Gold Mine." So called "greenstone-trap dykes" are occasionally encountered, sometimes running parallel to, and sometimes across, the strata. The beds of the streams frequently contain pebbles of *black tourmaline*, and the *black sand*, so common throughout this section of the country, was found to consist here principally of a magnesia tourmaline, easily fusible by the blowpipe. Immense veins, or rather *strata*, of black tourmaline were also observed in several places, usually veined with milky white quartz. This would form a magnificent material for monumental

and ornamental purposes. A turnpike road was found at one spot completely covered and blackened (*paved*, as it were,) for some distance with fragment and blocks of this material, in consequence of its crossing a large outcrop very obliquely. In one place was found the outcrop of a large vein of *ilmenite*. Veins of *pyrites* were found crossing the beds of streams, where the current appeared to have washed them bare, and one such vein was observed which had a well marked *schistose* structure, similar and conformable to that of the imbedding talcose rocks, forming a true *pyrites schist*. In other places solid banks of *limonite* were found, standing in place above the surface of the ground, indicating veins (or strata ?) of pyrites below. Specimens were seen of a crystalline *hematite schist*, said to form a large vein (or stratum ?) in Crowder's mountain, but this was not visited.

It was also perfectly evident, at most of the iron ore beds before mentioned, that the ore was merely the gozzan, or product of oxydation of large strata of *sulphids*, probably *pyrrhotine*, existing below. In some of these places, as at the Ormond, Ferguson and Briggs' Ore Banks, the mining operations have penetrated, in places, to the unaltered, or only partially altered, pyrites. At the Alison and Costner Ore Banks, which are excavations into *strata* of ore from thirty to forty feet in width, the material last thrown out is a true *magnetite schist*, mixed however with much limonite.

Throughout the whole range, wherever examined, the talcose schists were found to contain, in numerous places, small seams, incrustations and stains of a *black substance*, which gave blowpipe reactions for *cobalt*. At every one of the mines above mentioned the ore, or refuse material thrown out, was found to be more or less coated with this substance. At the Ormond Ore Bank, particularly, so much of this substance was found mixed with the ore that it is probably connected with the reputation of the iron produced from this ore, for hardness and toughness, throughout the surrounding country. At the Asbury Shaft of the Long Creek Mines also, masses of quartz thrown out from the vein were found thickly incrusted with mammillary masses of this *wad*, or earthy cobalt. It cannot be doubted that it is the gozzan of some cobaltiferous sulphid existing unaltered in the rocks below. If this substance has ever attracted the attention of mineralogical explorers in this section, it has probably been mistaken for earthy manganese, from which it may readily be distinguished, however, by being very soft, smearing the fingers, and when cut with a knife exhibiting on the section a bright black lustre like that of compact graphite; and to these properties it owes the designation of "black lead," which it bears among the people of the country (to whom it is familiar).

At a spot about a mile in a northeasterly direction from the Long Creek Mines I found, crossing at right angles the road from Lincolnton to Yorkville in S. C., where the latter crosses over an elevation called "Cross'" or the "Paysour mountain," the outcrop of a large "vein," or stratum of the rock, which contains very much of this black gozzan or wad. It can scarcely escape the attention of a person travelling along the road, as it appears like a broad black band at the side of the latter. At this spot it measures about fifteen feet in width. A small opening was made into it three or four rods from the road on the southern side, and it was found to be about twelve feet wide, included between walls of talcose slate, but so highly decomposed that no satisfactory evidence could be obtained of its character where unchanged. It was traced and opened again about half a mile southwesterly from the road, and found to consist there of a number of parallel strata, separated by seams of talcose schist one or two feet wide. The largest of these strata was ten feet wide, presenting a solid bank of limonite, mixed with a little quartz, so compact that it was with difficulty broken by a pick. Following the Yorkville road southerly from the point where this vein crosses it, are encountered, interstratified with the talcose schists, several narrow bands of a granular quartzose schist, corresponding precisely in character to the *itacolumite* of Humboldt, supposed to be the gangue of the *diamond*. No diamonds have however, to my knowledge, yet been found in this immediate neighborhood, although known localities of the gem are not far distant. In places this itacolumite is highly granular and friable, and would be called a *saccharoid* quartz schist. Such specimens call strongly to mind the so-called *flexible sandstone* of Mc Dowell Co., N. C., but no flexible specimens were observed.

Following the vein northwardly from the road, the outcrop was found to descend rapidly along the western slope of Cross' Mountain, and at about a quarter of a mile from the road was found a spot where the ground consisted in great part of fragments of the black cobaltiferous substance. Openings properly made here would probably lead to interesting and valuable developments. A determination of the quantity of mixed oxyds of cobalt and nickel contained in the mineral found at this spot, gave 13·26 per cent. The presence of oxyd of nickel in considerable proportion in this mixture was proved by the method of Liebig,* that is, by passing for some time, in the cold, a strong current of chlorine gas through the solution of the mixed oxyds, to which has been previously added large excesses of cyanid of potassium and caustic soda, the nickel being thus thrown down as a black precipitate of Ni^2O^3. No quantitative determination of the proportion of oxyd of nickel, however, has yet been made.

* Annalen der Chemie und Pharmacie, lxxxvii, 128.

This Cross' Mountain gozzan was found, by qualitative analysis, to contain besides *cobalt*, *nickel*, *manganese* and *iron*, small quantities of *copper*, *bismuth*, *zinc*, *lime*, *alumina*, *magnesia* and *glucina*. Traces of *sulphur* were also ascertained by Mr. Jas. R. Brant, to whom I am indebted for some assistance in the examinations. No traces of arsenic could be found.

In the mineral from the Asbury shaft, qualitative examination detected *iron*, *manganese*, *cobalt*, *nickel*, *copper*, *bismuth*, *zinc*, *alumina*, *silica*, *lime* and *magnesia*, besides traces of something which seemed to give the reactions of *tellurium*.* *Sulphur* in traces was found by Mr. Brant, but arsenic was sought for without success.

The substance from the Ormond Ore Bank may be called a cobaltiferous *earthy manganese*, or granular and amorphous *hausmannite*. It gives with chlorohydric acid a deep brown-black solution with evolution of chlorine (like hausmannite), which so-

* That this is really tellurium seems more probable in view of the unmistakeable indications obtained of the presence of the allied element, bismuth. These two elements, which form the connecting links between the arsenic and sulphur groups, seem, like Ni and Co, Ag and Pb, or Br and I, to preserve (at least in our American localities) a certain degree of concomitance in their occurrence. Thus the first known locality of both Bi and Te in the United States was announced by Prof. B. Silliman, Sen., in the first volume of the Am. Jour. of Science, p. 312, at Huntington, Conn. No further discovery of Te in the United States was recorded until Dr. Jackson's announcement of its existence at Whitehall, near Fredericksburg, Spotsylvania Co., Va., in the Am. J. Science for May, 1848, in the form of *tellurid of bismuth* or tetradymite. Since then tetradymite has been found at other Virginian localities, as the "Tellurium Mine," Fluvanna Co., and the "Monroe Mine," Stafford Co., and by Genth at several places in North Carolina, as at the "Phœnix" and "Boger Mines" in Cabarrus Co., and near the "Washington Mine" in Davidson Co. The only *South American* specimen yet described containing Te was a tellurid of Bi brought to Paris by Claussen from San José in Brazil, in which Damour found 79 p. c. Bi and 16 p. c. Te, with a little Se and S (see Ann. de Ch. et de. Ph., [3], xiii, 372). *Bismuth*, which, it will be observed, was found in small quantity in each of the three specimens examined, appears to be a rather common constituent of our crystalline schists. Besides the "Bismuth Mine" at Huntington, Conn., before alluded to, and the other long known localities at Trumbull and Monroe, Shepard has found it at Haddam, Conn. (Am. J. Sc., [2], xii, 220) and Jackson at the "Lubec Lead Mines" in Maine. The locality at "Brewer's Mine" in Chesterfield District, S. C., the *bismutite* from which was analyzed by Rammelsberg (Pogg. Ann., lxxvi, 564) and Genth (Am. J. Sci., [2], xxiii, 426) has long been known. In Genth's analysis an appreciable quantity of Te was found. Besides the several localities of tetradymite in Virginia and North Carolina before mentioned, Genth found *bismuthine* at Gold Hill, Rowan Co., N. C. (Am. J. Sci., [2], xix, 16), and Jackson states that *bismuth ochre* occurs with the Virginian tetradymites (Dana's Mineralogy, p. 141), and moreover, Genth has very recently (Am. J. Sci., [2], xxiii, 427, May, 1857) brought forward as a new locality of bismutite in North Carolina, *Gaston County* itself, where he says it was discovered by Dr. Asbury of Charlotte, the gentleman, if I mistake not, from whom the "Asbury Shaft" derives its name. In this also Genth obtained indications of the presence of *tellurium*.

With regard to South American localities of bismuth, besides the above-mentioned Brazilian tellurid of Damour, two others have thus far been recorded; one of which is at the mine of San Antonio, near Copiapo, Chili, whence was obtained a *bismuthet of silver*, containing, according to analysis of Domeyko, 10 p. c. of Bi, (Dana, p. 16), and the other is Rammelsberg's *chiviatite*, from Chiviato, Peru, a sulphid of Pb, Cu and Bi, containing 61 p. c. of Bi (Dana, p. 77).

lution contained *iron*, *manganese*, *cobalt*, *nickel*, *copper*, *bismuth*, *alumina*, *glucina*, and traces of *baryta*, *lead* and *magnesia*. There were in this also traces of *sulphur*, but no arsenic.

The Asbury Shaft and Cross' Mountain minerals give deep beautiful grass-green solutions in chlorohydric acid, with evolution of chlorine, which solutions become yellow-brown on adding water, a behavior characteristic of solutions containing considerable quantities of cobalt with iron, and by which these cobaltiferous wads may generally be distinguished from ordinary earthy manganese containing but traces of cobalt or none.

As to the nature of the *unaltered mineral*, from which these cobaltiferous gozzans have been derived by oxydation, it is possible to form a very probable hypothesis. The absence of *arsenic*, not only from these, but from many other minerals that I have examined from this region,* leads to the conclusion that this unaltered mineral must be a *sulphid*, and not an *arseniet* of cobalt and nickel, and the great resemblance of these substances to the cobalt and nickel ore from *Mine la Motte* in Missouri, which is also a product of oxydation, is presumptive evidence that the original mineral may be identical with, or at least similar to, the one existing there. Now this original mineral at Mine la Motte has recently been found by Dr. Genth† to be *siegenite*, containing 30·53 per cent of nickel and 21·34 of cobalt, together with iron and traces of lead, copper and antimony. The fact that the products of oxydation at the Cross' Mountain locality contain but 13 per cent of oxyds of cobalt and nickel is not against this hypothesis, for in the oxydation of such a mixture of sulphids, the produced sulphates of cobalt and nickel, particularly the latter, would be in great measure washed away,‡

* Arsenic indeed appears to be a sparsely distributed constituent of the schists of the Carolinas. Hardly any reliable *analytical* evidences of its occurrence in these latitudes are in existence. We have, however, one such evidence. A mineral found in minute quantities at the bismuth locality in Chesterfield District, S. Carolina, on analysis by Dr. Genth proved to be a sulpharsenate of sulphid of copper, most probably identical with the Peruvian species *enargite* (Am. J. Science, [2], xxiii, 420). Dana also (p. 62) mentions one specimen of *leucopyrite* found in Randolph Co., N. C.

† Am. Jour. Science, [2], xxiii, 419.

‡ It will be remembered that these two sulphates occur naturally, as *bieberite* and *pyromeline*, both products of oxydation of their corresponding sulphids. With regard to the relative tendencies of cobalt and nickel, when in *neutral* or *acid* solution, to undergo oxydation and precipitation as cobaltic and nicklic oxyds, our knowledge is rather meagre, but still experimental evidence bearing upon this point is not wholly wanting. Thus Dr. Gibbs found (Am. J. Science, [2], xiv, 205) that deutoxyd of lead partially oxydizes and precipitates Co from its solutions, but Ni not at all. This suffices to account for the fact that among the numerous analyses of *wads*, *earthy cobalts* and *bog manganese ores* on record, the presence of Ni is seldom or never indicated. The reason why, in *alkaline* solutions, as in the presence of an excess of ammonia or cyanid of potassium, the reverse action takes place, and the Ni is thrown down, while the Co remains in solution, is simply the eminent capacity which cobaltic oxyd possesses to form soluble double salts and conjugated compounds, a tendency apparently not shared by nicklic oxyd.

whilst the iron and manganese, passing to higher states of oxydation, would remain behind in insoluble forms. I cannot therefore refrain from offering the hypothesis that these veins, when opened to a depth below the influence of surface oxydation, will be found to contain either siegenite, or some nearly related species. As relevant to this view, I may cite the fact that Dr. Genth has recently discovered siegenite,* associated with chalcopyrite, pyrites, blende, etc., in the vein worked at the Mineral Hill Mine, Carroll Co., Md., in the same range of metamorphic schists as these North Carolina localities.

The only place in this neighborhood where a vein has been opened to a sufficient depth to expose the character of the unaltered ore, is what is called the "Bronson Shaft," at the Long Creek Mines, which has been recently worked for gold by a New York company, and is situated about half a mile southwesterly from the Asbury Shaft, and either on the same vein with the latter or on a closely parallel one. At this spot, however, unfortunately none of the black cobaltiferous substance occurs with the ore. I examined this mine and found that near the surface and above water level, the mineral mixed with the quartz gangue of the vein is principally limonite, as usual. Below water level, or about forty feet from the surface, the limonite begins to disappear, and the vein gradually assumes the character of a porous mass of quartz filled with strings and bunches of *pyrites* and "vugs" or cavities lined with crystals of the same, sometimes of the octahedral variety. Beautiful specimens were found containing contiguous cavities, some lined with cubic, and others with octahedral crystals, in the same specimen. The whole mass of the vein is here saturated, of course, with water. On descending to the bottom of the shaft, about 140 feet from the surface, the vein is first found *compact* and apparently unaltered, being here about eight feet wide, and composed of a mixture of quartz and *pyrrhotine.*

This pyrrhotine contains, however, but traces of cobalt and nickel. I wish to ask here whether it is not evident from the above facts, that the pyrites, as well as the limonite, found in the upper part of the Bronson shaft, is clearly a product of the action of aerated water upon the pyrrhotine? The pyrrhotine is compact and massive, with a granular fracture,† and no specimens were found in the bottom of the shaft presenting indications of crystallization, whilst all the pyrites found above presents, as before stated, an eminently crystalline structure, an in-

* Am. Jour. of Science, [2], xxiii, 418.

† The fractured surface presents a number of small patches of *chalcopyrite.* I may mention here that Prof. Emmons, in his recent Geological Report on North Carolina (pp. 167, 168) calls this pyrrhotine of the Long Creek Mines "arsenical pyrites." I could find, however, no trace of arsenic. It almost wholly dissolves in warm chlorohydric acid with copious evolution of sulphohydric gas.

dication, according to the crystallogenic views which are rapidly being generally adopted at the present day, of the agency of *water,* at or near the ordinary temperature, in its formation. Considering, for the sake of simplicity, as Breithaupt, von Kobell, Frankenheim and Rammelsberg have done,* that pyrrhotine is *protosulphid* of iron, the action of oxygeniferous water upon it in the formation of pyrites and limonite, may be represented by the rather simple equation

$$3FeS+2\frac{1}{2}HO+2O=FeS^2+Fe^2O^3,\ 1\frac{1}{2}HO+HS,$$

the sulphohydric acid formed entering into solution in the water, and subsequently either undergoing oxydation in its turn, or issuing in sulphur springs.†

ART. VI.—*On the so-called Triassic Rocks of Kansas and Nebraska;* by F. B. MEEK and F. V. HAYDEN.

IN several of our publications on the geology of Nebraska, we have mentioned a formation (No. 1 of the Nebraska Section) consisting of reddish and yellow sandstones, and various colored clays, with seams and beds of impure lignite, holding a position at the base of the Cretaceous series of the northwest. Although entertaining some doubts respecting the exact age of this formation, we have always placed it provisionally in the Cretaceous system, in our published sections.

Having learned through Mr. Hawn that a precisely similar group of strata, holding apparently the same position, occurs in northeastern Kansas, we placed these latter beds on a parallel with No. 1 of the Nebraska section, in a paper read before the Phila. Acad. Nat. Sci., May, 1857. Soon after the publication of this paper, however, a few fossils Mr. Hawn had shipped to us some time before, from a bed near the base of a section of the Kansas rocks he had furnished us for publication, came to hand. On examining these fossils, we at once discovered they were not, as had been supposed, Cretaceous forms, but similar to those of the Permian of the Old World. From this it became manifest that in drawing a parallel between the Kansas and Nebraska formations, we had carried No. 1 too low in Kansas, by bringing it down so as to include the bed from which these fossils had been obtained.

* Handwörterbuch der Chem. Lieb. Pogg. and Woehler, v, 62.

† These views will be recurred to in a future communication, to be presented whenever I shall have been able to complete my chemical examinations of the minerals collected in this section, and in which I propose to bring forward some general considerations regarding the metamorphism of the crystalline schists of the United States, and the nature and origin of the included metalliferous veins.

This misunderstanding in regard to the lower limits of No. 1, in Kansas, also led us to place on a parallel with that formation, all the lower two-hundred feet of Mr. Marcou's Pyramid Mountain section, (New Mexico) referred by him to the Trias. Suspecting however, that No. 1, as thus defined, might possibly include beds not properly belonging to it, we distinctly stated in the closing remarks of the same paper, that we yet wanted positive evidence, we might not be making it include beds older than any part of the Cretaceous system.

Although we are now aware that in drawing this parallel between the Nebraska rocks and those of Kansas and New Mexico, we carried No. 1, too low, we yet regard all, or nearly all of Mr. Marcou's Pyramid Mountain section, referred by him to the Jurassic System, as equivalent to the Cretaceous formations No. 1, 2 and 3, of Nebraska; while the lower two hundred feet of the Pyramid Mountain referred by Mr. Marcou to the Trias, we think equivalent to the Kansas deposits between the base of No. 1, as we now understand it, and the beds containing the Permian fossils.

In our paper on the collections brought in by Lieut. Warren's expedition to the Black Hills, read before the Acad. Nat. Sci., Philad., March, 1858, we remarked that in consequence of the occurrence in No. 1, of the genus *Baculites,* and numerous leaves closely resembling those of some of the higher types amongst our existing dicotyledonous forest trees, we thought we were hazarding little in referring it to the Cretaceous epoch.

More recently Mr. Hawn has published a paper in the Transactions of the St. Louis Acad. Sci. in which he places this formation in Kansas and New Mexico (as we had done), on a parallel with No. 1, of the Nebraska section, but refers the whole to the Trias.*

This difference of opinion caused us to examine with no little interest, during our recent expedition to Kansas, some of the localities mentioned by Mr. Hawn, near the junction of the Grand Saline and Smoky Hill branches of Kansas river, with the view of determining definitely whether or not the formation regarded by him as Triassic, could really be the same as No. 1 of the Nebraska section. In this we were particularly successful, for we not only found these Kansas formations agreeing exactly in all the details of their lithological characters, with No. 1, in Nebraska, but we also discovered in them several good specimens of the same dicotyledonous leaves so abundant in No. 1, at the mouth of Big Sioux river, and at Blackbird Hill, on the Missouri, in Nebraska. Associated with these leaves we likewise found specimens of the same peculiar trilobate leaf

* Trias of Kansas, by F. Hawn, Trans. St. Louis Acad. Sci., vol. i, p. 171.

(*Ettingshausinia*) mentioned by Mr. Hawn* as occurring in the formation referred by him to the Trias, thus establishing beyond the possibility of a reasonable doubt, the identity of the supposed Triassic deposits of Kansas, and No. 1, of the Nebraska section.

In regard to the leaves here referred to, we would merely remark that they are quite abundant in this formation, both in Nebraska and Kansas, and certainly belong to higher and more modern types of dicotyledonous trees, than have yet been found even in Jurassic rocks. Dr. J. S. Newberry our excellent authority in fossil botany, to whom we have submitted the whole collection, decidedly concurs with us in the opinion that the rocks in which they occur cannot be older than lower Cretaceous. In a communication recently received from him respecting these remains he says: "They include so many highly organized plants, that were there not among them several genera exclusively Cretaceous, I should be disposed to refer them to a more recent era."

"A single glance is sufficient to satisfy any one they are not Triassic. Up to the present time no angiosperm dicotyledonous plants have been found in rocks older than the Cretaceous, while of the eighteen species which comprise your collection sixteen are of this character." * * * *

"The species of your fossil plants are probably all new; though generally closely allied to the Cretaceous species of the Old World. From the limited study I have given them I have referred them to the following genera:

Sphenopteris.	Pyrus?
Abietites.	Alnus.
Acer.	Salix.
Fagus.	Magnolia.
Populus.	Credneria.
Cornus.	Ettingshausinia."
Liriodendron.	

"Of these the last two are exclusively Cretaceous, and highly characteristic of that formation in Europe.

* * * * * * *

"I may say in confirmation of the assertion that your fossil plants are Cretaceous, that I found near the base of the yellow sandstone series in New Mexico, considered Jurassic by Mr. Marcou,—a very similar flora to that represented by your specimens, one species at least being identical with yours, associated with *Gryphæa*, *Inoceramus*, and *Ammonites* of lower Cretaceous species."

* Prof. Swallow exhibited a specimen of this species at the Baltimore meeting of the Am. Association.

We have only to add in regard to the formation under consideration that we think it will no longer be doubted that it really belongs where we have always placed it, in the Cretaceous System.*

Between the base of No. 1 and the beds from which the Permian fossils are obtained in Kansas, there is a considerable thickness of red, blue, green and whitish clays, with a few beds of sandstone, and near the base gypsum deposits. This series may,—at least in part,—be Jurassic or Triassic or both, (much more probably the former), but until we have some reliable palæontological evidence, it would only be groping in the dark to attempt to define its age; knowing as we do that lithological characters are of no value whatever, as a guide in drawing a parallel between these formations and those of the Old World.

As we expect soon to publish a paper giving in more detail the results of our examinations amongst the rocks in which so many Permian fossils have been found in Kansas, we would merely remark here that the coal measures of that region pass upwards by imperceptible gradations into an extensive series of rocks, consisting usually of rather impure more or less magnesian limestones, alternating with generally much thicker beds of blue, green, red and ash-colored laminated clays or very soft shales, with occasional beds of sandstone. Into this series, nearly all the species of fossils found in the middle and intermediate coal measures pass in great numbers.† Associated with these however, we occasionally meet with fossils belonging to types regarded in the Old World as characteristic of the Permian epoch.

* After the reception of a brief preliminary report by us, published last winter in the National Intelligencer, on the collections brought in from the Black Hills by Lieut. Warren, Mr. Marcou published a paper in the *Archives des Sciences de la Bibliotheque Universelle* of Geneva (a translation of which has recently appeared in the New York Mining Journal) in which after speaking of some points of difference in our opinions respecting the geology of the far west, he says, "in other respects the series of Messrs. Meek and Hayden agrees perfectly with mine, and it is with great pleasure I see that these learned geologists admit not only the existence of the New Red Sandstone (Permian and Trias) and Jurassic, but that they are led to regard as Jurassic, formation No. 1, of their Nebraska Cretaceous Series, a formation which from their description, I have no hesitation in regarding as Jurassic."

It was perhaps owing to the necessary brevity of our preliminary statement of the Jurassic and other discoveries in the Black Hills, seen by Mr. Marcou in the Intelligencer, that he misunderstood us. We have no where said we had recognized the Trias in the northwest; nor have we admitted in any of our publications that No. 1, of the Nebraska section is Jurassic. We stated that in consequence of the similarity between the lithological characters of No. 1, and the Jurassic deposits in the Black Hills, and the absence of organic remains near the junction, we were in doubt respecting the particular horizon at which the line should be drawn between them. At the same time, we stated that the beds from which the Jurassic fossils, described by us were obtained, hold a position *below* No. 1, of the Nebraska section.

† Amongst these we recognize nearly all the Carboniferous fossils figured by Mr. Marcou in his "Geology of North America."

As we ascend in this group of strata, which comprises, nearly or quite all the lower Permian, and much of the upper coal measures of Prof. Swallow's and Mr. Hawn's section* we find the Carboniferous forms very gradually diminishing in numbers to be replaced by Permian types, or others rather intermediate in their affinities, between those of the Permian and Carboniferous epochs.

Still higher in the series, without passing any horizon of unconformability, or meeting with any *abrupt* change, either in the fossils, or the lithological characters of the rocks, we find, when fairly up into the Upper Permian of Prof. Swallow's and Mr. Hawn's section, that we have lost sight of nearly, or quite, all the coal measure types, and meet only with Permian forms.

From these facts, we are inclined to the opinion that the entire series, from near the top of the Lower Permian of Prof. Swallow's and Mr. Hawn's section, down even lower than the horizon where they draw the line between the coal measures and the lower Permian,† should be regarded as intermediate in age, and as filling the hiatus between the Permian and upper coal measures of the Old World; while we think only the Upper Permian of their section really represents the Permian rocks, as developed on the other side of the Atlantic.

This intermediate series might be very appropriately termed the Permo-Carboniferous group, to indicate its relations both to the Permian and Carboniferous rocks. In case however, it may be thought best, in order to avoid the inconvenience of introducing a new name into our nomenclature, to class it along with either the Permian or Carboniferous, we would certainly place it in the latter, since Carboniferous types greatly predominated in its fauna.

In conclusion we would state that there is no unconformability so far as our knowledge extends, amongst all the rocks of Nebraska and northeastern Kansas, from the coal measures to the top of the most recent Cretaceous. The whole series in N. E. Kansas, and along the Missouri, as far up as Heart river in Nebraska, where the latest Cretaceous deposits pass beneath the water level, dip to the northwest. Consequently the elevating forces that produced this inclination of these various formations, must have been called into play—as in the region of the Black Hills,—after the close of the Cretaceous epoch, and previous to the deposition of the Miocene Tertiary formations of the northwest.

* Transactions St. Louis Acad. Sci., vol. i, p. 171.

† We found the genus *Monotis* ranging down several hundred feet below the base of what we understand to be the lower Permian in Prof. Swallow's and Mr. Hawn's section.

ART. VII.—*On Lazulite, Pyrophyllite and Tetradymite in Georgia*; by CHARLES UPHAM SHEPARD.

WHILE at Allatoona, Ga., in April last, Mr. S. Harris of that place received a small blue crystal from Dr. Stephenson of Lincoln county, the name of which the Doctor wished to learn. It being handed over to me for determination, I found it to be Lazulite. The form of the crystal was well defined, and wholly different from any specimens I had ever seen from Lincoln county, or from elsewhere. This decided me to visit the locality if possible, on my way back to Charleston. On making the necessary inquiries for my route, I learned with surprise, that instead of coming from Lincoln county, N. C., it was from a county of the same name in Georgia, the two being several hundred miles apart.

Want of time however, prevented my reaching nearer than within twelve miles of the spot; but I was fortunate to obtain the assistance of Dr. Stephenson in procuring a supply of the mineral. He was good enough to visit the locality twice, attended by two miners; and has favored me with a description of the circumstances under which lazulite occurs.

The locality is upon Graves' mountain, a ridge three hundred feet high and two miles in length. This elevation is situated about twelve miles northwest of the short auriferous belt, known as the Columbia gold mines in a county of the same name, lying fifty miles above Augusta. Graves' mountain is supposed to be the southwestern terminus of a second parallel gold belt, which extending across South Carolina, includes the famous Dorr mine, and afterwards runs away into North Carolina. The central part of the mountain, to the thickness of fifty feet, is composed of a hematitic rock, which includes in some places an abundance of a ferruginous kyanite, much resembling in appearance the diaspore from the Urals. With the kyanite is found rutile, often in gigantic crystals (weighing upwards of a pound), and possessed of much regularity of crystalline form. The prevailing figure is a square prism with truncated lateral edges, and surmounted at both extremities by an eight-sided pyramid. There is also found a most remarkably perfect twin crystal, in which the geniculation is six times repeated,—producing an hexagonal prism, surmounted at each end by a six-sided pyramid, with a reëntering, six-sided, hopper-shaped cavity, at the tips. These crystals are all more remarkable for their symmetry and polish, than any I have ever seen. Some are fully equal in lustre to the brilliant crystals of cassiterite from Cornwall or Bohemia. The most perfect rutiles are generally imbedded in the massive kyanite; and when detached leave behind impressions having a

polish and lustre equal to that of their own planes. A little common quartz is also mingled with the kyanite and rutile. Occasionally small imbedded crystals of quartz, of the form of those found in the Trenton limestone of New York, are seen in the kyanite.

Closely associated with kyanite, rutile and quartz, are considerable masses (eight or ten inches thick) of a mineral known among the miners of Georgia as steatite, but which is true pyrophyllite,—differing in no respect from that of the Urals, except in the finer stellulations it presents, and in the slight ferruginous stain it exhibits near their centres.

The hematite is massive, granular (approaching compact); but the masses are somewhat open, from including the decomposing ferruginous kyanite, particles of pyrophyllite and even portions of compact rutile. The large masses consequently possess a somewhat slag-like and roughened aspect; and suggest, on being handled, the presence of some native metal. It is possible that this hematite may contain titanium as a constant ingredient; in which case it may prove a new mineral.

To the southeast of this fifty feet band, appears the itacolumite, with a thickness of more than three hundred feet, which presents numerous included zones or layers, varying from one to three feet in thickness, in which is found imbedded, masses and crystals of lazulite. The continuity of the lazulite is by no means perfect,—the mineral rather exhibiting a tendency to form nests and bunches. Within a few feet of the surface, the rock is loose and sandy, and presents a pale buff color; but at a depth of three feet, it approaches compactness, with a greyish white color. It is obscurely schistose, with a tendency only to cleavage, and at intervals not nearer than two or three inches. The lazulite is almost wholly in crystals, varying from a quarter to one inch in length; and are scattered like garnets through granite or mica slate, presenting a very pleasing appearance from the contrast between the ultramarine blue of the mineral, and the clear, pale buff of the rock.

The itacolumite contains traces of gold, especially near the southern extremity of the formation, where it becomes more schistose and embraces minute crystals of pyrites. It has here been worked to some extent for the precious metal.*

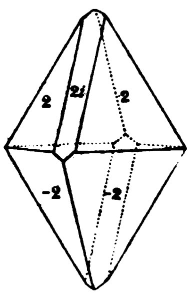
* The aspect of many specimens of the hematitic mixture of kyanite and quartz suggests a resemblance to the diamond gangue of Brazil; and I can but regard this spot as well worthy of being examined for the diamond. Dr. Stephenson informs me that at least ten crystals of this gem have been found in Burke county, two in Habersham, two in Hall and one in Union county. The largest of these is said to have sold for $150 in Philadelphia. The whole number of diamonds thus far found in the United States cannot therefore be less than thirty, nearly all of which occurred in itacolumite.

A greenish, massive kyanite, with scales of white mica (often partially decomposed so as to resemble talc), occurs very rarely in little bunches, in the vicinity of the lazulite crystals. Among these, the naked eye often detects minute and nearly transparent red crystals of rutile. Those of a still smaller size, and visible only with the aid of a lens, are pretty widely diffused through the rock, and often coat the rough surfaces and joints of the lazulite crystals themselves.

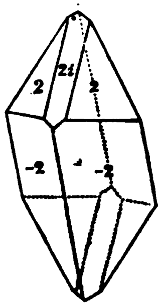
Small drusy cavities very rarely occur in the itacolumite, pretty nearly filled with barytes, massive and crystalline. Very minute and perfectly formed transparent crystals of quartz are discernible in the barytes, likewise microscopic crystals of sulphur. The form of the barytes is that represented in fig. 513 of Dana, coming from the gold formation (itacolumite?) of Fauquier county, Va.

The crystals are represented by the following figures, obligingly furnished by Prof. Dana; and are lettered in accordance with the figure of a lazulite crystal on p. 404 of his Mineralogy. The rarest of these forms is figure 1, of which I have

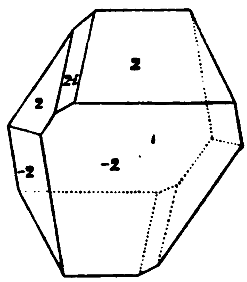
1.



2.



3.



detected only three crystals. Fig. 2 is very common, and is the result of a vertical elongation of the crystal, producing a slightly rhombic prism with very oblique dihedral summits, having slightly truncated edges. The planes $2i$ are always much narrower than in the figures. The crystals of the form of fig. 2 are always small, rarely above one-third of an inch in length. Figs. 3 and 4 are unsymmetrical modifications of fig. 1, in which the right hand planes 2 and -2 are horizontally prolonged, and in fig. 4 are possessed of very unequal dimensions, thus giving rise to a very flattened crystal. The crystals of fig. 3 are the largest found, sometimes measuring above one inch in length.

4.

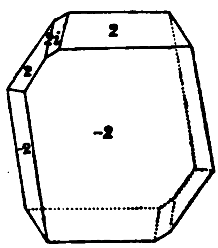
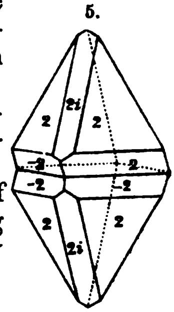


Figure 5, a twin, is by far the most abundant form, equalling in frequency all the others combined. It results from the composition of two such forms as figure 1. The plane of composition is coincident with the rhombic base of the figure; and the angle of revolution $=180°$.

5.



The faces of none of these crystals are sufficiently polished to allow of the use of the reflecting gonimeter.

The color of the lazulite is various shades of berlin and indigo blue. The effect of weathering is, to lower the intensity of the blue, and rarely to give rise to a shade of green.

Tetradymite in Lumpkin county.

An important discovery of gold has been made during the last summer in the middle of the Chestatee river, four miles east of Dahlonega. It occurs in seams in hornblendic gneiss. Accompanying the gold were found considerable quantities of a white foliated massive mineral, having nearly the color and lustre of tin, which was taken for silver by the miners, though to others it suggested the idea of platinum and even of molybdenite. Several specimens were forwarded to me for examination by Dr. M. F. Stephenson and by W. F. Harris, Esq. I find it to be tetradymite, a species I had before observed in small quantities along with gold, at the Pascoe mine in Cherokee county, and at a place near Van Wort in Polk county.

From the specimens sent, it appears that the gangue of the mineral is gneiss; though in a specimen from Mr. Harris it is diffused in seams through granular white calcite, rendering the mass as heavy as barytes, for which substance it appears, on this account, to have been mistaken.

In both gangues, it is attended by gold.* A number of specicimens of the gneiss included with quartz veins, were sent to me for inspection. The quartz veins are transverse to the stratification of the gneiss, and vary in thickness from one to two inches. They contain irregularly shaped masses of pyrrhotine (intermingled with traces of chalcopyrite), chlorite, angular fragments of green hornblendic gneiss, cleavable calcite, ilmenite in broad highly curved crystals, to which may be added a few crystals of allanite and grains of yellow apatite.† A few

* As it has a very pale brass-yellow color and assays at the mint only from 717 to 800, while the deposit gold in the vicinity varies from 910 to 920, it is possible it may be an alloy of gold and bismuth, analogous to the sample I examined several years ago from the Charlotte, N. C., mint, and for which, in the event of its occuring in nature, I have suggested the name of Bismuthaurite.

† This is the only instance in which I have detected apatite in the Southern states; where beryl, also, appears to be equally rare.

grains of reddish garnet are also visible in the gneiss, near its junction with the quartz veins.

The tetradymite is a very handsome metallic mineral. It is broadly laminated for the most part, though sometimes approaching granular in structure. In one instance it is reported to have occurred in foliæ three or four inches across. I have not seen it in perfect crystals. It contains very rarely, minute forms of a silver-white pyrites not yet determined. The tetradymite when first heated before the blowpipe, evolves a distinct odor of selenium.

When in granular calcite, it is accompanied by small crystals of a brownish, semi-transparent mineral, in prisms resembling tourmaline, but whether they belong to this species I have been unable to determine.

Leadhillite occurs in small quantity at the Morgan silver lead mine, in Spartanburg district, South Carolina. It is associated with pyromorphite and cerusite.

Art. VIII.—*Address by Lord Brougham on the Inauguration of a Statue to Sir Isaac Newton.**

To record the names and preserve the memory of those whose great achievements in science, in arts, or in arms have conferred benefits and lustre upon our kind, has in all ages been regarded as a duty and felt as a gratification by wise and reflecting men. The desire of inspiring an ambition to emulate such examples generally mingles itself with these sentiments; but they cease

* From the London Times, September 23.

Grantham, Tuesday, September 21, 1858.—Lincolnshire enjoys the proud distinction of having given to the world the illustrious mathematician and philosopher, Sir Isaac Newton—justly described as "the greatest genius of the human race"—who was born at the manor-house of Woolsthorpe, a hamlet eight miles from this town, on Christmas Day, 1642. Sir Isaac was a posthumous child, his father having died, at a comparatively early age, some three months before the birth of a son whose reputation will endure "to the last syllable of recorded time." Mrs. Newton re-married, and the embryo philosopher seems to have remained under the care of his maternal grandmother and uncle until he attained the age of twelve, when he was sent to the grammar-school at Grantham. While at school he displayed an extraordinary inclination for mechanics, and busied himself, during the time devoted by his schoolmates to play, in making models of various kinds, chiefly clocks and sun dials, one of the latter of which is still to be seen carved upon the walls of the old manor-house at Woolsthorpe. He was entered, in 1661, at Trinity College, Cambridge, where he was fortunate enough to secure the friendship of the learned Dr. Isaac Barrow, who had been elected Greek Professor in 1660, and who became Lucasian Professor in 1663. In the autumn of 1667, Newton was elected a minor fellow; on the 16th of March, 1668, he was elected a major fellow; and on the 29th of October, 1669, he was appointed Lucasian Professor, in the room of Dr. Barrow, who is said to have resigned with a view to his appointment, and from this period may be dated the development of those wonderful scientific discoveries which have given him a world-wide and time-enduring reputation. It is unnecessary to trace further the career of this great philosopher, over whose giant intellect a sad

not to operate even in the rare instances of transcendent merit, where matchless genius excludes all possibility of imitation, and nothing remains but wonder in those who contemplate its triumphs at a distance that forbids all attempts to approach. We are this day assembled to commemorate him of whom the consent of nations has declared that he is chargeable with nothing like a follower's exaggeration or local partiality, who pronounces the name of Newton as that of the greatest genius ever bestowed by the bounty of Providence for instructing mankind on the frame of the universe, and the laws by which it is governed:

> "Qui genus humanum ingenio superavit, et omnes
> Restinxit; stellas exortus uti ætherius sol."—(*Luc.*)

> "In genius who surpassed mankind as far
> As does the mid-day sun the midnight star."—(*Dryden.*)

But, though scaling these lofty heights be hopeless, yet is there

cloud subsequently passed, but who died at a green old age, in his 85th year, but unmarried, on the 20th of March, 1727.

The relations of Sir Isaac, who inherited his personal estate, devoted the sum of £500 to the erection of a monument to his memory in Westminister Abbey, but in his case the proverb that a prophet is honored everywhere save in his own country and among his own people, has, until recently, been verified. Some three or four years ago, however, the inhabitants, or the Town Council, of Grantham, bethought themselves that some ornament was required for a vacant space of ground which is styled St. Peter's Hill, though it seems to be little, if at all, above the dead level of the Lincolnshire fens. It was suggested, and the suggestion was favorably received, that the most appropriate ornament would be a monument to the memory of a man whose early career was so closely identified with the town and neighborhood, and whose researches had conferred an eternal benefit upon mankind. A committee was formed to carry out this object, and Mr. Thomas Winter, a member of the Town Council—to whose untiring zeal and energy its successful accomplishment is, we believe, mainly attributable—undertook to act as the honorary secretary. Mr. Winter at once placed himself in communication with Lord Rosse, Lord Brougham and other gentlemen of distinction in the literary and scientific world, who evinced a warm interest in the success of the scheme. Under these auspices the project received the sanction of the Royal Society, and the patronage of Her Majesty and the Prince Consort, who aided the fund by a subscription of £100. A general meeting of the subscribers was held in 1854, at St. George's Hall, Liverpool, during the *séance* in that town of the British Association for the Advancement of Science, when it was resolved that the memorial should be a bronze statue, and its execution was intrusted by the Committee of Selection to Mr. William Theed, the result of whose labors is not only creditable to himself, but not unworthy of the great philosopher whose memory it perpetuates. A detailed description of the statue appeared in the *Times* of Thursday last. The likeness of Sir Isaac is copied from the mask of his face taken after death, and from a portrait bust by Roubilliac. It represents him in the costume of the period, and in the gown of a Master of Arts, in the act of lecturing. The figure is nearly thirteen feet high, weighing upwards of two tons, and about half the quantity of the material of which it is composed was presented in the shape of old gun metal, by Her Majesty's government. The statue was cast at the foundery of Messrs. Robinson and Cottam, of Pimlico, and as a specimen of clean casting, with sharp outline, does them high credit. The figure stands upon a pedestal of Anglesey marble, designed by Mr. Theed, and cut by Mr. Rogers, of Park Hill. The total height of the pedestal and figure is twenty-seven feet, and its cost is £1,630. of which £600 were contributed by the inhabitants of Grantham and the neighborhood.

some use and much gratification in contemplating by what steps he ascended. Tracing his course of action may help others to gain the lower eminences lying within their reach, while admiration excited and curiosity satisfied are frames of mind both wholesome and pleasing. Nothing new, it is true, can be given in narrative, hardly anything in reflection, less still perhaps in comment or illustration; but it is well to assemble in one view various parts of the vast subject, with the surrounding circumstances, whether accidental or intrinsic, and to mark in passing the misconceptions raised by individual ignorance or national prejudice, which the historian of science occasionally finds crossing his path. The remark is common and is obvious, that the genius of Newton did not manifest itself at a very early age. His faculties were not, like those of some great and many ordinary individuals, precociously developed. Among the former, Clairaut stands preëminent, who at nineteen years of age presented to the Royal Academy a memoir of great originality upon a difficult subject in the higher geometry, and at eighteen published his great work on curves of double curvature, composed during the two preceding years. Pascal, too, at sixteen, wrote an excellent treatise on conic sections. That Newton cannot be ranked in this respect with those extraordinary persons is owing to the accidents which prevented him from entering upon mathematical study before his eighteenth year; and then a much greater marvel was wrought than even the Clairauts and the Pascals displayed.

His earliest history is involved in some obscurity, and the most celebrated of men has, in this particular, been compared to the most celebrated of rivers (the Nile), as if the course of both in its feebler state had been concealed from mortal eyes. We have it, however, well ascertained that within four years, between the ages of eighteen and twenty-two, he had begun to study mathematical science, and had taken his place among its greatest masters; learnt for the first time the elements of geometry and analysis, and discovered a calculus which entirely changed the face of the science, effecting a complete revolution in that and in every branch of philosophy connected with it. Before 1661 he had not read *Euclid;* in 1665 he had committed to writing the method of fluxions. At twenty-five years of age he had discovered the law of gravitation, and laid the foundation of celestial dynamics, the science created by him. Before ten years had elapsed he added to his discoveries that of the fundamental properties of light. So brilliant a course of discovery in so short a time, changing and reconstructing analytical, astronomical, and optical science, almost defies belief. The statement could only be deemed possible by an appeal to the incontestible evidence that proves it strictly true. By a rare felicity these

doctrines gained the universal assent of mankind as soon as they were clearly understood; and their originality has never been seriously called in question.

Some doubts having been raised respecting his inventing the calculus—doubts raised in consequence of his so long withholding the publication of his method—no sooner was the inquiry instituted than the evidence produced proved so decisive that all men in all countries acknowledged him to have been by several years the earliest inventor, and Leibnitz at the utmost, the first publisher, the only question raised being, first, whether or not he had borrowed from Newton; and next, whether, as second inventor he could have any merit at all,—both which questions have long since been decided in favor of Leibnitz. But undeniable though it be that Newton made the great steps of this progress, and made them without any anticipation or participation by others, it is equally certain that there had been approaches in former times by preceding philosophers to the same discoveries. Cavalieri, by his Geometry of Indivisibles (1635), Roberval, by his Method of Tangents (1367), had both given solutions which Descartes could not attempt; and it is remarkable that Cavalieri regarded curves as polygons, surfaces as composed of lines, while Roberval viewed geometrical quantities as generated by motion; so that the one approached to the differential calculus, the other to fluxions; and Fermat, in the interval between them, comes still nearer the great discovery by his determination of *maxima* and *minima*, and his drawing of tangents. More recently Hudden had made public similar methods invented by Schœtin; and what is material, treating the subject algebraically, while those just now mentioned had rather dealt with it geometrically. It is thus easy to perceive how near an approach had been made to the calculus before the great event of its final discovery. There had in like manner been approaches made to the law of gravitation, and the dynamical system of the universe. Galileo's important propositions on motion, especially on the curvilinear motion, and Kepler's laws upon the elliptical form of the planetary orbits, the proportion of the areas to the times, and of the periodic times to the mean distances; and Huygens's theorems on centrifugal forces had been followed by still nearer approaches to the doctrine of attraction. Borelli had distinctly ascribed the motion of the satellites to their being drawn towards the principal planets, and thus prevented from flying off by the centrifugal force. Even the composition of white light, and the different action of bodies upon its component parts had been vaguely conjectured by Ant. de Dominis, Archbishop of Spalatro, at the beginning, and more precisely in the middle of the 17th century by Marcus (Kronland, of Prague,) unknown to Newton, who only refers to the

Archbishop's work; while the treatise of Huygens on light, Grimaldi's observation on colors by inflexion, as well as on the elongation of the image in the prismatic spectrum, had been brought to his attention, although much less near to his own great discovery than Marcus's experiment.

But all this only shows that the discoveries of Newton, great and rapid as were the steps by which they advanced our knowledge, yet obeyed the law of continuity, or rather of gradual progress, which governs all human approaches towards perfection. The limited nature of man's faculties precludes the possibility of his ever reaching at once the utmost excellence of which they are capable. Survey the whole circle of the sciences, and trace the history of our progress in each, you find this to be the universal rule. In chemical philosophy the dreams of the Alchemists prepared the way for the more rational, though erroneous, theory of Stahl; and it was by repeated improvements that his errors, so long prevalent, were at length exploded, giving place to the sound doctrine which is now established. The great discoveries of Black and Priestley, on heat and aeriform fluids had been preceded by the happy conjectures of Newton and the experiments of others. Nay, Voltaire had well nigh discovered both the absorption of heat, the constitution of the atmosphere, and the oxydation of metals; and by a few more trials might have ascertained it. Cuvier had been preceded by inquirers who took sound views of fossil osteology, among whom the truly original genius of Hunter fills the foremost place. The inductive system of Bacon had been, at least in its practice, known to his predecessors. Observations and even experiments were not unknown to the ancient philosophers, though mingled with gross errors; in early times, almost in the dark ages, experimental inquiries had been carried on with success by Friar Bacon, and that method actually recommended in a treatise, as it was two centuries later by Leonardo da Vinci, and at the latter end of the next century Gilbert examined the whole subject of magnetic action entirely by experiments. So that Lord Bacon's claim to be regarded as the father of modern philosophy rests upon the important, the invaluable step of reducing to a system the method of investigation adopted by those eminent men, generalizing it, and extending its application to all matters of contingent truth, exploding the errors, the absurd dogmas, and fantastic subtleties of the ancient schools, and above all, confining to the subject of our inquiry, and the manner of conducting it, within the limits which our faculties prescribe. Nor is this great law of gradual progress confined to the physical sciences; in the moral it equally governs. Before the foundations of political economy were laid by Hume and Smith, a great step had been made by the French philosophers, disciples of

Quesnai; but a nearer approach to sound principles had signalized the labors of Gournay, and those labors had been shared and his doctrines patronized by Turgôt when Chief Minister. Again, in constitutional policy, see by what slow degrees, from its first rude elements, the attendance of feudal tenants at their lord's court, and the summons of burghers to grant supplies of money, the great discovery of modern times in the science of practical politics has been effected, the representative scheme which enables states of any extent to enjoy popular government and allows mixed monarchy to be established, combining freedom with order—a plan pronounced by the statesmen and writers of antiquity to be of hardly possible formation, and wholly impossible continuance. The globe itself, as well as the science of its inhabitants, has been explored according to the law which forbids a sudden and rapid leaping forward, and decrees that each successive step, prepared by the last, shall facilitate the next. Even Columbus followed several successful discoverers on a smaller scale, and is by some believed to have had, unknown to him, a predecessor in the great exploit by which he pierced the night of ages, and unfolded a new world to the eyes of the old. The arts afford no exception to the general law. Demosthenes had eminent forerunners, Pericles the last of them. Homer must have had predecessors of great merit, though doubtless as far surpassed by him as Fra Bartolomeo and Pietro Perugino were by Michael Angelo and Raphael. Dante owed much to Virgil; he may be allowed to have owed, through his Latin Mentor, not a little to the old Grecian; and Milton had both the orators and the poets of the ancient world for his predecessors and his masters. The art of war itself is no exception to the rule. The plan of bringing an overpowering force to bear on a given point had been tried occasionally before Frederick II. reduced it to a system; and the Wellingtons and Napoleons of our own day made it the foundation of their strategy as it had also been previously the main-spring of our naval tactics.

It has oftentimes been held that the invention of logarithms stands alone in the history of science, as having been preceded by no step leading towards the discovery. There is, however, great inaccuracy in this statement, for not only was the doctrine of infinitesimals familiar to its illustrious author, and the relation of geometrical to arithmetical series well known, but he had himself struck out several methods of great ingenuity and utility (as that known by the name of Napier's Bones)—methods that are now forgotten, eclipsed as they were by the consummation which has immortalized his name. So the inventive powers of Watt, preceded as he was by Worcester and Newcomen, but far more materially by Causs and Papin, had been exercised on

some admirable contrivances, now forgotten, before he made the step which created the steam-engine anew—not only the parallel motion, possibly a corollary to the proposition on circular motion in the *Principia*, but the separate condensation, and above all, the governor, perhaps the most exquisite of mechanical inventions; and now we have those here present who apply the like principle to the diffusion of knowledge, aware, as they must be, that its expansion has the same happy effect, naturally preventing mischief from its excess which the skill of the great mechanist gave artificially to steam, thus rendering his engine as safe as it is powerful.

The grand difference, then, between one discovery or invention and another is in degree rather than in kind; the degree in which a person, while he outstrips those whom he comes after, also lives, as it were, before his age. Nor can any doubt exist that, in this respect, Newton stands at the head of all who have extended the bounds of knowledge. The sciences of dynamics and of optics are especially to be regarded in this point of view, but the former in particular; and the completeness of the system which he unfolded, its having been at the first elaborated and given in perfection, its having, however new, stood the test of time, and survived, nay gained by, the most rigorous scrutiny, can be predicated of this system alone, at least in its high degree. That the calculus, and those parts of dynamics which are purely mathematical, should thus endure for ever is a matter of course. But his system of the universe rests partly upon contingent truths, and might have yielded to new experiments and more extended observation. Nay, at times it has been thought to fail, and further investigation was deemed requisite to ascertain if any error had been introduced—if any circumstance had escaped the notice of the great founder. The most memorable instance of this kind is the discrepancy supposed to have been found between the theory and the fact in the motion of the lunar apsides, which about the middle of the last century occupied the three first analysts of the age. The error was discovered by themselves to have been their own in the process of their investigation; and this, like all the other doubts that were ever momentarily entertained, only led in each instance to new and more brilliant triumphs of the system. The prodigious superiority in this cardinal point of the Newtonian to other discoveries, appears manifest upon examining almost any of the chapters in the history of science. Successive improvements have, by extending our views, constantly displaced the system that appeared firmly established. To take a familiar instance, how little remains of Lavoisier's doctrine of combustion and acidification, except the negative positions, the subversion of the system of Stahl! The substance having most eminently the prop-

erties of an acid (chlorine) is found to have no oxygen at all, while many substances abounding in oxygen, including alkalies themselves, have no acid property whatever; and without the access of oxygenous or of any other gas heat and flame are produced in excess.

The doctrines of free trade had not long been promulgated by Smith before Bentham demonstrated that his exception of usury was groundless; and his theory has been repeatedly proved erroneous on colonial establishments, as well as his exception to it on the navigation laws; and the imperfection of his views on the nature of rent is undeniable, as well as on the principle of population. In these and such instances as these it would not be easy to find in the original doctrines the means of correcting subsequent errors, or the germs of extended discovery. But even if philosophers finally adopt the undulatory theory of light instead of the atomic, it must be borne in mind that Newton gave the first elements of it by the well known proposition in the 8th section of the Second Book of the *Principia*, the scholium to that section also indicating his expectation that it would be applied to optical science; while Biot has shown how the doctrine of fits of reflection and transmission tallies with polarization, if not with undulation also.

But the most marvellous attribute of Newton's discoveries, that in which they stand out prominent among all the other feats of scientific research, stamped with the peculiarity of his intellectual character—is this, that their great author lived before his age, anticipating in part what was long after wholly accomplished, and thus unfolding some things which at the time could be but imperfectly, others, not at all, comprehended, and not rarely pointing out the path and affording the means of treading it to the ascertainment of truths then veiled in darkness. He not only enlarged the actual dominion of knowledge, penetrating to regions never before explored, and taking with a firm hand undisputed possession; but he showed how the bounds of the visible horizon might be yet further extended, and enabled his successors to occupy what he could only descry; as the illustrious discoverer of the new world made the inhabitants of the old cast their eyes over lands and seas far distant from those he had traversed; lands and seas of which they could form to themselves no conception, any more than they had been able to comprehend the course by which he led them on his grand enterprise. In this achievement, and in the qualities which alone made it possible, inexhaustible fertility of resources, patience unsubdued, close meditation that would suffer no distraction, steady determination to pursue paths that seemed all but hopeless, and unflinching courage to declare the truths they led to, how far soever removed from ordinary apprehension—in

these characteristics of high and original genius we may be permitted to compare the career of those great men. But Columbus did not invent the mariner's compass as Newton did the instrument which guided his course and enabled him to make his discoveries, and his successors to extend them by closely following his directions in using it. Nor did the compass suffice to the great navigator without making any observations, though he dared to steer without a chart; while it is certain that by the philosopher's instrument his discoveries were extended over the whole system of the universe, determining the masses, the forms, and the motions of all its parts by the mere inspection of abstract calculations and formulas analytically deduced. The two great improvements in this instrument which have been made—the calculus of variations by Euler and Lagrange, the method of partial differences by d'Alembert—we have every reason to believe were known at least in part to Newton himself. His having solved an isoperimetrical problem (finding the line whose revolution forms the solid of least resistance,) shows clearly that he must have made the coordinates of the generating curve vary, and his construction agrees exactly with the equation given by that calculus. That he must have tried the process of integrating by parts in attempting to generalize the inverse problem of central forces before he had recourse to the geometrical approximation which he has given, and also when he sought the means of ascertaining the comet's path, which he has termed by far the most difficult of problems, is eminently probable, when we consider how naturally that method flows from the ordinary process for differentiating compound quantities, by supposing each variable in succession constant; in short, differentiating by parts. As to the calculus of variations having substantially been known to him no doubt can be entertained. Again: in estimating the ellipticity of the earth, he proceeded upon the assumption of a proposition, of which he gave no demonstration, (any more than he had done of the isoperimetrical problem,) that the ratio of the centrifugal force to gravitation determines the ellipticity.

Half a century later, that which no one before knew to be true, which many probably considered to be erroneous, was examined by one of his most distinguished followers, Maclaurin, and demonstrated most satisfactorily to be true. Newton had not failed to perceive the necessary effects of gravitation in producing other phenomena beside the regular motion of the planets and their satellites in their course round their several centres of attraction. One of these phenomena, wholly unsuspected before the discovery of the general law, is the alternate movement to and fro of the earth's axis, in consequence of the solar (and also of the lunar) attraction combined with the earth's motion. This

libration, or nutation, distinctly announced by him as the result of the theory, was not found by actual observation to exist till sixty years and upwards had elapsed, when Bradley proved the fact. The great discoveries which have been made by Lagrange and Laplace upon the results of disturbing forces have established the law of periodical variation of orbits, which secures the stability of the system by prescribing a *maximum* and a *minimum* amount of deviation; and this is not a contingent, but a necessary truth, by rigorous demonstration, the inevitable result of undoubted *data* in point of fact, the eccentricities of the orbits, the directions of the motions, and the movement in one plane of a certain position. That wonderful proposition of Newton, which, with its corollaries, may be said to give the whole doctrine of disturbing forces, has been little more than applied and extended by the labors of succeeding geometricians. Indeed, La Place, struck with wonder at one of his comprehensive general statements on disturbing forces in another proposition, has not hesitated to assert that it contains the germ of Lagrange's celebrated inquiry exactly a century after the *Principia* was given to the world.

The wonderful powers of generalization, combined with the boldness of never shrinking from a conclusion that seemed the legitimate result of his investigations—how new and even startling soever it might appear—was strikingly shown in that memorable inference which he drew from optical phenomena, that the diamond is "an unctuous substance coagulated"; subsequent discoveries having proved both that such substances are carbonaceous, and that the diamond is crystallized carbon; and the foundations of mechanical chemistry were laid by him with the boldest induction and most felicitous anticipations of what has since been effected. The solution of the inverse problem of disturbing forces has led Le Verrier and Adams to the discovery of a new planet, merely by deductions from the manner in which the motions of an old one are affected, and its orbit has been so calculated that observers could find it—nay, its disc as measured by them varies less than a second from the amount given by the theory. Moreover, when Newton gave his estimate of the earth's density, he wrote a century before Maskelyne, who, by measuring the force of gravitation in the Scotch mountains, gave the proportion to water as 4·716 to 1; and, many years after, Cavendish, by experiments with mechanical apparatus, (1798) corrected this to 5·48, and Baily, more recently (1842) to 5·66, Newton having given the proportion as between five and six times. In these instances he only showed the way and anticipated the result of future inquiry by his followers. But the oblate figure of the earth affords an example of the same kind, with this difference, that here he has himself perfected the discovery and nearly completed the demonstration. From the

mutual gravitation of the particles which form its mass, combined with their motion round its axis, he deduced the proposition that it must be flattened at the poles; and he calculated the proportion of its polar to its equatorial diameter. By a most refined process he gave this proportion upon the supposition of the mass being homogeneous. That the proportion is different in consequence of the mass being heterogeneous does not in the least affect the soundness of his conclusion. Accurate measurements of a degree of latitude in the equatorial and polar regions, with experiments on the force of gravitation in those regions, by the different lengths of a pendulum vibrating seconds, have shown that the excess of the equatorial diameter is about 11 miles less than he had deduced it from the theory; and thus that the globe is not homogeneous. But on the assumption of a fluid mass, the ground of his hydrostatical investigation, his proportion of 229 to 230 remains unshaken, and is precisely the one adopted and reasoned from by Laplace, after all the improvements and all the discoveries of later times. Surely at this we may well stand amazed, if not awe-struck.

A century of study, of improvement, of discovery, has passed away, and we find Laplace master of all the new resources of the calculus, and occupying the heights to which the labors of Euler, Clairaut, D'Alembert and Lagrange have enabled us to ascend, adopting the Newtonian fraction of 1 : 230 as the accurate solution of this speculative problem. New admeasurements have been undertaken upon a vast scale, patronised by the munificence of rival governments; new experiments have been performed with approved apparatus of exquisite delicacy; new observations have been accumulated, with glasses far exceeding any powers possessed by the resources of optics in the days of him to whom the science of optics as well as dynamics owes its origin; the theory and the fact have thus been compared and reconciled together in more perfect harmony; but that theory has remained unimproved, and the great principle of gravitation, with its most sublime results, now stands in the attitude, and of the dimensions, and with the symmetry, which both the law and its application received at once from the mighty hand of its immortal author. But the contemplation of Newton's discoveries raises other feelings than wonder at his matchless genius. The light with which it shines is not more dazzling than useful. The difficulties of his course and his expedients, alike copious and refined for surmounting them, exercise the faculties of the wise while commanding their admiration. But the results of his investigations, often abstruse, are truths so grand and comprehensive, yet so plain, that they both captivate and instruct the simple. The gratitude, too, which they inspire, and the veneration with which they encircle his name, far from tending to obstruct future improvement, only proclaim his disciples the

zealous because rational followers of one whose example both encouraged and enabled his successors to make further progress. How unlike the blind devotion to a master which for so many ages of the modern world paralysed the energies of the human mind!—

> "Had we still paid that homage to a name
> Which only God and Nature justly claim,
> The western seas had been our utmost bound,
> The poets still might dream the sun was drown'd,
> And all the stars that shine in southern skies
> Had been admired by none but savage eyes."

Nor let it be imagined that the feelings of wonder excited by contemplating the achievements of this great man are in any degree whatever the result of national partiality, and confined to the country which glories in having given him birth. The language which expresses her veneration is equalled, perhaps exceeded, by that in which other nations give utterance to theirs; not merely by the general voice, but by the well-considered and well-informed judgment of the masters of science. Leibnitz, when asked at the royal table in Berlin his opinion of Newton, said that, "taking mathematicians from the beginning of the world to the time when Newton lived, what he had done was much the better half." "The *Principia* will ever remain a monument of the profound genius which revealed to us the greatest law of the universe," are the words of Laplace. "That work stands preëminent above all the other productions of the human mind." "The discovery of that simple and general law, by the greatness and the variety of the objects which it embraces, confers honor upon the intellect of man." Lagrange, we are told by D'Alembert, was wont to describe Newton as the greatest genius that ever existed, but to add "how fortunate he was also, because there can only once be found a system of the universe to establish." "Never," says the father of the Institute of France—one filling a high place among the most eminent of its members—"Never," says M. Biot, "was the supremacy of intellect so justly established and so fully confessed. In mathematical and in experimental science without an equal and without an example, combining the genius for both in its highest degree." The *Principia* he terms the greatest work ever produced by the mind of man, adding, in the words of Halley, "that a nearer approach to the Divine nature has not been permitted to mortals." "In first giving to the world Newton's method of fluxions," says Fontenelle, "Leibnitz did like Prometheus—he stole fire from Heaven to bestow it upon men." "Does Newton," L'Hôpital asked, "sleep and wake like other men? I figure him to myself as a celestial genius, entirely disengaged from matter."

To so renowned a benefactor of the world, thus exalted to the loftiest place by the common consent of all men—one whose life,

without the intermission of an hour, was passed in the search after truths the most important, and at whose hands the human race had received only good, never evil—it is befitting that no memorial should have been raised by nations which erect statues to the tyrants and conquerors, the scourges of mankind. * * * * But that his own countrymen justly proud of having lived in his time, should have left this duty to their successors, after a century and a half of professed veneration and lip homage, may well be deemed strange. The inscription upon the cathedral, masterpiece of his celebrated friend's architecture, may possibly be applied in defence of this neglect: "If you seek for a monument, look around." "If you seek for a monument, lift up your eyes to the heavens, which show forth his fame." Nor, when we recollect the Greek orator's exclamation, "The whole earth is the monument of illustrious men," can we stop short of declaring that the whole universe is Newton's. Yet in raising the statue which preserves his likeness, near the place of his birth, on the spot where his prodigious faculties were unfolded and trained, we at once gratify our honest pride as citizens of the same state, and humbly testify our grateful sense of the Divine goodness which deigned to bestow upon our race one so marvellously gifted to comprehend the works of Infinite Wisdom, and so piously resolved to make all his study of them the source of religious contemplations, both philosophical and sublime.

ART. IX.—*Description of a new Mineral Species from Chili;* by FREDERICK FIELD. (From a letter to J. D. DANA, dated Guyacana, Coquimbo, Chili, September 6, 1858).

I SEND you a specimen of a mineral from the Cordilleras of Chili, which appears to me highly interesting. It consists entirely of copper, arsenic and sulphur, having the following composition:

Copper,	48·50
Sulphur,	31·82
Arsenic,	19·14
Iron, silver,	*traces.*
	99·46

and consequently has the following formula: $3Cu_2S+AsS_5$, and may be considered as a tribasic sulpharseniate of copper, like the artificial tribasic sulpharseniate of potassium, in which that metal is replaced by Cu_2. Hardness 3·5—4. Sp. gr. 4·39.

You will see it resembles Tennantite in which the arsenic takes the place of the iron; a specimen of Tennantite having the following value: Cu 48·2, As 12·5, Fe 9·0, S 31·14. I have proposed the name "*Guayacanite*" for this new species, as the mineral was first brought to the large copper smelting works of Guayacana.

Art. X.—*Geographical Notices.* No. V.

Recent Surveys of the Amoor River.—The opening of the Chinese Empire, the negotiation of a commercial treaty with Japan, and the spread of the Russian dominion over the Amoor region and Manchooria, in respect to which intelligence has recently been received, are events which combine to give peculiar interest and importance to our meagre knowledge of Eastern Asia.

The proceedings in China and Japan have attracted universal attention. The advances of Russia, however, in developing the resources of its legitimate territory and in acquiring new domains, have been conducted in a manner so quiet as to escape general attention and elude the opposition of diplomatic vigilance. Siberia has been so little known, and so much depreciated by the world at large, that the accession of some thousands of square miles to its territory has passed almost unnoticed. But it will not be many years before the Russian policy on the Amoor river will be appreciated as it deserves, and already the demand has become urgent in this country for definite knowledge in respect to a region with which American relations are likely to grow continually more intimate.

To satisfy in part such inquiries, the Government at Washington has lately published (Wash. 67 pp., 8vo) a "Report of Explorations on the Amoor river," which were made last year by Mr. P. McD. Collins, an American citizen, who received from the President, in 1856, an appointment, without a post, as "United States Commercial Agent for the Amoor river," and who travelled over land from the Baltic to the Pacific, endeavoring to ascertain what relations might be established with advantage between our own country and the possessions of Russia in Eastern Asia.

The official rank of Mr. Collins gave him opportunities of intercourse with Gen. Mouravieff, the Governor of Eastern Siberia, and with many other dignitaries, from whom he gathered some important facts in respect to the Russian policy in that region. In addition to these, he states his own observations made on a hurried tour through a region of vast extent and varied resources. His report accordingly will be valuable to those who are interested in political changes, and to American merchants, but the circumstances under which it was prepared were by no means favorable to the collection of scientific materials. Three hastily constructed maps, (without the indications of latitude and longitude,) appended to the volume, add almost nothing to our knowledge.

Mr. Collins crossed the Urals at Ecatherinberg, and then proceeded by Tumen, Omsk and Tomsk to Irkootsk, where he remained a month. He then visited Kyatcha and Mai-mat-tschin, neighboring towns,—the former Russian, the latter Chinese,—in which the chief exchanges of the two empires are effected. After returning to Irkootsk, he went on to Chetah, visited the celebrated mines of Nerchinsk and then proceeded to Chilkah, from which place, in a small row-boat, with two or three companions, beside a crew of five men, he followed the Amoor to its mouth. This river voyage of about 2600 miles he made in fifty two days.

The impressions of Mr. Collins are favorable in every respect to the introduction of American commerce. The river is said to be navigable by steamboats from the junction of the Schilka and Argoon to its mouth. The neighboring country is thickly settled, various articles of export, especially furs and hides, are abundant, and manufactured goods are in demand. Many of Mr. Collins's incidental remarks in respect to agriculture and mining are of an interesting character, but his report must be looked at as a collection of "Observations" rather than as the result of "Explorations." Coming as it does from an American it may serve to draw attention to the much more elaborate and satisfactory investigations which have been conducted during the last few years under the direction of the Russian government.

Before proceeding to enumerate the more important of these expeditions and their several characteristics we stop to inquire the occasion of the impulse lately given to Siberian explorations.

The immense capacity of Russia for producing raw materials has long demanded freer communication between the interior and the coast, both in the east and in the west, than has hitherto been enjoyed. The complete control by the Czar of the Amoor river would have almost as much influence on the development of Siberian resources as the control of the Dardanelles on the prosperity of Russia proper. Let the navigation of the stream be made easy, and a few lines of railway established, and the empire of Russia will be as open as any country to the trade of China, Japan, the East Indies and America.

Taking advantage of the unsettled condition of the country around the Amoor, Russia has been for some years quietly pushing her out-posts farther and farther into the proper dominions of China. Precisely what has been her progress and what are now the claims of her "manifest destiny," can only be learned in the cabinet of St. Petersburg. This much is evident. By the treaty of Russia with China in 1689,* after the well known defeat

* Cf. Petermann on the Amur Stream. Geogr. Mittheil, 1856. p. 472.

at Albasin, and also by the treaty of 1727, the boundary between the two empires was the Northern watershed of the Amoor river on the Stanovoi mountains, leaving the entire basin of the river, east of the junction of the Schilka and Argoon in possession of the Chinese. It was so delineated on the official charts of Russia. In 1844–5, von Middendorf, under instructions from the Imp. Acad. of Sciences in St. Petersburgh, proceeded to determine on the spot the exact boundary line. He reported that the Chinese did not claim as far north as the watershed, but only as far on the left bank of the Amoor as the tributaries were navigable for small boats. Without further ceremony, so far as it appears, some fifty thousand square versts on the south of the Stanovoi summits were accordingly indicated on the charts as belonging to Russian dominion.

The Crimean war caused the removal of large bodies of troops, often under highly intelligent officers, quite to the Pacific coast, for the defence of such Russian possessions as were threatened by the allied fleets. About that time not less than five Russian forts were "provisionally" established on the Amoor, between Ust-Strelotschnaja and the mouth of the Sungari. Nicolaieff, at the mouth of the Amoor river, was fortified, and even so far south (on the right bank of the Amoor) as De Castries bay the Russian flag was raised and a fort erected. The actual possession of the Amoor was thus completed. By recent advices it appears that Russia, in addition to a commercial treaty like that of the other powers, has obtained a treaty conceding to it all of the Amoor territory which had thus been occupied. What are the exact limits of this concession we are not yet informed.

There can be no question that Russia will employ to its own advantage the aggrandizements thus made, but whether its next advances will be in China, or Japan or the English possessions in India the future will reveal. It will not be forgotten that Russia was the first power which watched the movements of Com. Perry in Japan, nor on the other hand that Japan has long been suspicious of its Muscovite neighbor, having even dispatched a special agent to the Amoor river to discover if possible the ulterior purpose of the movements in that region.*

The considerations which we have now presented sufficiently explain the recent energy which Russia has displayed in the explorations of the Amoor. So many scientific investigators have now visited that country that we may anticipate at an early day vast accessions to our knowledge of Eastern Asia. Already the outlines which have been communicated to the world, and which may be found for the most part in the comprehensive "Mittheilungen" of Dr. Petermann, are sufficient to awaken a profound

* Perry's Japan. i. 32.

interest. * It would not be difficult to compile from them a far more reliable and complete report of the Amoor country than could be derived from the observations of many non-scientific travellers.

We proceed to specify some of the accounts of the Russian explorations.

1. We mention first a Report of Peschtschuroff, who accompanied Count Putiatin around Cape Horn to Japan and afterward returned by way of Irkootsk to St. Petersburgh. His astronomical determinations of twenty-three points on the River Amoor, between its mouth and its commencement were published two years ago. More recently he has furnished a hydrographic description of the upper portion of the river from Ust-Strelotschnaja to the mouth of the Sungari, with some general statements in respect to the characteristics of the whole stream and many interesting ethnographical remarks. He refers in this report to a special chart of the Amoor in twelve sheets on a scale of two miles to an English inch (about 1:146000) which has been constructed from the sketches of Lieut. Popoff. Dr. Petermann publishes what he supposes to be a reduction of this chart, adding however some corrections obviously demanded by Peschtschuroff's data. The observations now making by Lieut. Roskoff may be expected to give still further accuracy to these delineations. The fact is not concealed that there are obstructions to navigation, especially numerous islands.

2. Herr Permikin has reported to the Imp. Geograph. Society of Russia in respect to the Geology and Natural History of the entire stream. Between the Sungari and the mouth of the Amoor, his journal may be considered in its general statements as supplemental to that of Peschtschuroff.

3. Leopold Schrenk's report to the Academy of Sciences gives an outline of his journey down and up the whole course of the Amoor. He has made important collections for scientific purposes. Thirty of his boxes containing specimens in Natural History, were at the date of recent advices on their way to St. Petersburgh. His investigations of the island Sachalen and his examination of the region around the mouth of the stream, and as far up as the Ussuri are particularly extended.

4. Since 1855, the Imperial Geographical Society of Russia has sustained a party of explorers known as the "East Siberian Expedition" under the direction of the astronomer Schwarz. Its

* The more important of these articles, extending through four volumes of the Mittheilungen (Gotha, 1855–8), are the following:—
1856, p. 175. Latest Russian Acquisitions in the Chinese Territory; by Dr. Petermann. p. 472. Peschtschuroff's Surveys on the Amoor; by the same. 1857, p. 296. The Amoor Stream; by the same. p. 518. L. Schrenk's Latest Researches. 1858, p. 70. Maximowitsch's Researches on the Amoor.

original design was to survey in three years Trans Baikal, and the district between the upper Lena and the Wittim. But the investigations having extended on one side to the Amoor and having been impeded on the other, the party was to continue in the field during 1858. Notices of the progress of the expedition by Dr. Schirren have been printed from time to time in the Berlin "Zeitschrift für allgemeine Erdkunde." The May number of that journal contains a brief summary of the labors of each member of the party during the last three years. Lieut. Roshkoff has been especially charged with the Amoor survey. Radde has been making Natural History investigations in part of its neighborhood.

Roshkoff determined the position of twenty-one places and surveyed the route from Ust-Strelotschnaja to Albasin and from Marien station to Nicolaieff, and the part of the river between his surveys were surveyed by Lieut. Sondhagen.

5. Around the mouth of the Amoor river, and for a considerable distance upon the coast to the North and South, the Russian flotilla has collected much information of importance in navigation. Some of these details are given in the report of the Russian Admirals Sawojka and Putiatin in respect to the naval operations in the straits of Tartary, in 1855, which is published in the official journal of the Ministry of the Marine.

The English cruisers made at the same period soundings and observations, especially around the island of Sachalen, many of which are given in Whitingham's Notes on the late expedition against the Russian Siberia Settlements. (Lond. 1856.)

6. The last investigations to which we call attention are those of Maximowitsch, who has been travelling for the Imperial Botanical Garden of St. Petersburgh. His letters have been published in the bulletin of that establishment, and many of the plants which he collected described by Ruprecht. Maximowitsch travelled part of the time with Schrenk, and part of the time independently.

From this brief indication of the explorations which have lately been made under the patronage or direction of the Russian government, it is evident that we may look for vast accessions at an early day to our knowledge of the Amoor country. All its characteristics have been so little known heretofore, that much has now been unquestionably gained in different departments of natural science. The commercial world will not be long in appropriating the important results of these various investigations.

New Maps of Tropical America.—The German publishers have recently issued three important maps of different parts of Tropical America based upon recent surveys and authentic travels.

The most complete of these charts is Kiepert's "New Map of Central America," published in four sheets, Berlin, Reimer. It includes the territory between 76° and 79° long. west from Greenwich, and between 6° and 22° N. lat. Although immense districts within these limits are unexplored, this map will be found of very great value, as an accurate presentation of what is known. The scale is 1 : 2,000,000. Upon it, there are five subordinate maps. 1. The state of San Salvador, and the proposed Honduras Rail Road from the surveys of E. G. Squier and W. H. Jeffers, in 1853. Scale, 1 : 1,000,000. 2. The isthmus of Tehuantepec as surveyed for a proposed railway, in 1851, by Col. Barnard. Scale 1 : 1,000,000. 3. The river San Juan de Nicaragua, from the survey in 1847, published in 1851 by A. von Bulow. Scale 1 : 500,000. 4. Isthmus and Rail Road of Panama, from the surveys in 1849 by Col. C. W. Hughes. Scale 1 : 400,000. Tract of the proposed Inter-oceanic Canal of the river Atrato, from the surveys of W. Kennish in 1854. Scale 1 : 400,000.

In reference to the materials used in constructing this map, the following note is given by the compiler.

"The coast lines are copied from the British Admiralty charts, surveyed on the Atlantic side principally by Capt. Owen, on the Pacific side from New Granada westward to Point Herradura in Costarica by Capt. Kellett. The part not yet entirely surveyed by the British Navy, from that point to the Isthmus of Tehuantepec has been retained from the old Spanish charts, with some corrections in the principal bays and harbors, made by British French and American seamen.

"Of the interior no part has hitherto been satisfactorily surveyed, with the only exception of the measurements executed for the proposed canal and railroad lines and their next environs on the isthmuses of Tehuantepec, Comayagua, Lake Nicaragua and Panama, specified with the names of the authors on the cartons accompanying this map. The other parts of the map on whose accuracy most confidence may be placed are the following: 1, the part of the New Granadian territory east of the 80th degree, reduced from a map compiled with the aid of old Spanish documents, and corrected by some new surveys by Col. Augustino Codazzi, (published in Berlin, 1857); 2, the central or cultivated part of the state of Costarica, taken from a MSS. map by Mr. Alexander von Bülow; 3, the greater part of the states S. Salvador, Honduras and Nicaragua, copied after the surveys executed in 1851–53 by Messrs. Squier, Jeffers and Hitchcock; 4, the northern part of Yucatan, from a Spanish map, corrected by personal observation and published by Mr. Heller, an Austrian naturalist in 1848.

"To the same gentleman we are indebted for the new intelligence produced on the southern part of the state of Tabasco. All available works of other distinguished travellers (viz. Messrs. Thompson in 1825, Dunn 1827, Legh Page 1834, Montgomery 1838, Stephens 1838–39, Dunlop 1844–46, Wagner and Scherzer 1853–54, and others,) have been consulted in order to correct and to complete the other parts of the map, especially the state of Guatemala the rest of the detail being taken with the necessary precaution in the drawing of the mountains, from the well known but not entirely authentic map of Mr. Baily."

A second chart in two sheets, covering part of the territory included in the map just mentioned, has also been published by Reimer. It is entitled "Carte de l'Isthme de Panama et de Darien, et de la province de Choco." It is based on the surveys of Augustin Codazzi, Colonel in the New Granada corps of Engineers, and is edited by Dr. Kiepert. It is printed on two sheets, on a scale of 1 : 800,000. Subordinate maps (corresponding with those above mentioned) of the routes of the Panama Rail Road and the proposed Atrate canal are also given. In the outlines of the coast, Mr. Codazzi has based his chart on the surveys of the English engineer, Mr. Kellet, published in 1854, with the introduction, however, of some changes. Dr. Kiepert, who is conscientiously exact in all his publications, is forced in a note which accompanies this map, to express his doubts as to the reliability of the delineations of the interior of the country.

A third map, recently issued by the same editor and publisher, is entitled "Tropical America North of the Equator," and comprises the West Indies, Central America, Mexico, New Granada, and Venezuela. It is composed with the help of all cartographic and literary materials hitherto published. One of the sheets contains a subordinate map of the central part of the Mexican Republic on an enlarged scale. The entire work is executed with great clearness and precision.

Recent Explorations in South Australia.—We condense from the Berlin "Zeitschrift für allgemeine Erdkunde" for August, 1858, the following interesting notice of late explorations in South Australia. In the year 1857 two explorations were made under the auspices of the Colonial government into the northern part of the mountainous region which extends from Spencer Gulf north-easterly and nearly to the bottom of the vast curve formed by Lake Torrens. This singular lake, now supposed to consist of immense morasses, salt pools, and shallow expanses of fresh water—so shallow as to be dry during a portion of the year—appears to commence to the northward of Spencer Gulf, (with which it is partially connected by a valley of towards 400 yards in length,) and, extending northerly three degrees, to sweep N.E., E., S.E., then southerly in 140 E. long. to a point

nearly opposite the place of commencing. The mountain land above alluded to, as enclosed by Lake Torrens, consists of the Flinders range, which runs in a nearly straight and unbroken line or belt from the vicinity of Port Augusta north-easterly to 30° 40′ S. lat., and of the Pound Range, etc., a series of detached peaks or spurs, appearing to branch off in all directions from the northern extremity of the Flinders Range. The main object of these explorations seems to have been to lay open new and desirable grazing lands, and thus to direct intelligently the course of colonization. Accordingly Goyder, who made the first exploration in May and June, especially noted vegetation, followed the course of streams, fixed the position of fresh-water springs or pools, and when he reached the south shore of the bend of Lake Torrens in 29° 13′ S. lat. joyfully reports it "as an apparently interminable body of *fresh* water flowing with a decided current towards the northwest." He describes the north shore, as seen through a telescope, as covered with vegetation, and yet he makes no mention of the depth, real or apparent, of the water. As we shall afterwards see, the government was misled into the conclusion that this portion of the lake was navigable, and that it might be made the highway to unexplored wealth in the heart of the continent. Nor was this the only point in which his report proved an unsafe guide. His glowing pictures of the fertility of large portions of the soil were based partly on near at hand observations during the most favorable period of the year when the streams were full, and partly also on bird's-eye views, from the summits of mountains, of wide reaches of landscape invested with the deceitful colors of the *mirage.*

Freeling's expedition, undertaken in consequence of Goyder's report, and in the following September, was chiefly directed to the navigation of Lake Torrens from the point where Goyder had observed it "flowing in a northwesterly direction." For this purpose he was provided with a small iron boat. On his arrival at the above named point, Freeling to his surprise found the water to have receded more than half a mile. The soil thus laid bare was "clay, mixed with sand, without stones;" so too the shore for a mile inland, bore the same character, but arid and cracked into fissures by the heat of the sun. From the very slight elevation of the shore, which bore the appearance of sandy flats, as well as from drift-wood and water-marks, it seemed probable that the lake had already receded some six miles, even at the time of Goyder's visit. Freeling was at once convinced that the lake was not navigable, but he resolved not to return until baffled by actual experiment. He accordingly made three successive attempts to reach deep water. On the preliminary trial he waded but a short distance out, sank ankle-deep in mud

overflowed with water only one inch deep. He then had the boat brought, and this, though on other occasions a light burden for two men, was now, in consequence of the mud, carried with difficulty by six, one quarter of a mile, where finding only two inches of water, they returned. The final experiment was extremely dangerous. The party waded knee-deep through viscid and tenacious mud, three miles from the shore, and found but six inches of water. They were much fatigued with the labor, and under constant apprehension at every step of sinking in some treacherous quagmire, and were rejoiced at their "good fortune in coming upon two small islands, raised but little above the general level, where they rested before retracing their course." Two of the party, however, more courageous than the rest, pushed on for the north shore, thinking to wade across the lake. Their hardihood had nearly proved fatal, for after accomplishing about two miles farther, they became so exhausted, that it was only by the utmost labor that they were enabled to rejoin their comrades. They reported the water somewhat deeper and the mud slightly more yielding. Thus ended the expectations of the government in that quarter. Freeling pronounces the appearance of the lake, its islands, and the opposite shore as seen by Goyder to be due to the *mirage.*

The expedition of Stephen Hack in the summer of 1857 from Streaky Bay to Lake Gairdner and its vicinity, has proved of far greater practical importance than either of the two already noticed. "The new grazing lands discovered to the south of Lake Gairdner comprise an area of more than 4,500 square miles." Hack skirted the south shore of this great lake, but for various sufficient reasons he was obliged to discontinue his explorations, and he returned across the country to Port Augusta. Mr. Harris, surveyor to the expedition, took by azimuth observations, combined with determinations of latitude, the position of all permanent bodies of fresh water, and of the mountains passed on the route, and charted the outlines of the lake-shore by the results of trigonometrical measurements. Mr. Hack's original intention was to have rounded the sourthernmost bay of Lake Gairdner and ascertained its entire outlines upon the east. He thinks there is reason to suspect some union between Lake Torrens and Lake Gairdner, and perhaps that they are one and the same great expanse. It is hinted that the geographical notes of this expedition are of great interest and importance, but they have not yet come to hand. Meanwhile we may judge of the pressing need in South Australia of more extended pasturage, by the fact that within one week after Mr. Hack's return, negotiations were pending for the purchase of about 2000 of the 4,500 square miles of meadow land newly discovered by him. And shortly previous to this, one of the largest proprietors had

been compelled to send a herd of his cattle to New South Wales to graze.

An expedition in charge of Mr. Swinden to explore the region to the west of Lake Torrens left Port Augusta in August, 1857; but the notes we have of it are short and unsatisfactory, amounting to little more than the bare mention of distances between one creek, pool, or spring, and another, and of the character of the water in each, whether brackish or fresh. The great number of such bodies of water, and their nearness to each other, have excited much interest respecting this region, and the reader will doubtless be pleased to learn that a strongly equipped expedition is probably now on the ground, and that the vigorous prosecution of the instructions which Mr. B. Herschell Babbage, its leader, received from the government in February, 1858, will soon result in an accurate knowledge of this now unknown territory. We may add that there are accompanying this expedition, not only a surveyor, but a chemist and a botanist.

Height of the Himalayan Peaks.—The survey, now in progress in Caschmir and Thibet, under the direction of Col. A. S. Waugh, has lately determined the height of one of the peaks of Kara-Korum, and ascertained it to be 27,928 English feet, more than 1000 feet above the Dhaulagiri, and therefore the third in height of all the peaks in the world yet measured.

The following measurements are given for the highest Himalayan peaks:

Mount Everest	29,002	English feet.
Kintschindjunga	28,156	"
Kara-Korum	27,928	"
Dhaulagiri	26,826	"
Tschumalari	23,946	"

Guyot's Physical Tables.—Upon another page of this number a detailed account is given of the Meteorological and Physical Tables, prepared with the greatest care, by Prof. Arnold Guyot, of which a second enlarged edition has reeently been published (Washington, Smithsonian Institution, 1858). We allude to the subject here for the sake of calling the attention of those who are interested in geographical investigation, to a variety of tables which they will find of great convenience and value.

D. C. G.

Yale College Library, Dec. 4, 1858.

ART. XI.—*Biographical Notice of Dean Conybeare and Alcide D'Orbigny;* by Major General PORTLOCK, President of the Geological Society of London.*

1. DEAN CONYBEARE.

IT has been justly said of Dean Conybeare that he was one of a *race* of clergymen, and those, men of intellectual eminence. His grandfather was Dean of Christchurch and Bishop of Bristol, the friend of Bishop Berkely, and the author of a work distinguished even in an age of deep thinkers and profound theologians, entitled, "The Defence of Revealed Religion." The Bishop's only son, Dr. Willian Conybeare, Rector of Bishopsgate, left behind him two sons, both of whom were eminent men. The elder, John Josias, Vicar of Bath Easton, was an accomplished scholar, no inconsiderable chemist, a sound geologist, and filled with credit the University offices of Professor of Poetry and of Anglo-Saxon, as well as that of Bampton Lecturer: he promoted the revival of Saxon literature, and left behind him, on his death in early life, a volume of translations which it was his brother's office to complete and edit. That brother, the second son of Dr. William Conybeare, was the illustrious object of this notice, William Daniel Conybeare: he was born in June 1787, and in due time sent to Westminister School, where he received his early education. From Westminister he proceeded to Oxford, and entered Christ Church in the same year as his fellow collegian Sir Robert Peel, taking a first class in classics, in which he was classed with Sir Robert, and a second class in mathematics, in which he was classed with Archbishop Whately. Until he took his M.A. degree, he continued to reside at the University, pursuing various studies, and assisting by his exertions to lay the foundation of geology, which was then only a rising science. At the early portion of the present century, an indifference, such as we can now scarcely understand, as to the cultivation of the natural sciences prevailed at Oxford; but, in the midst of the consequent general neglect, a small band of individuals, residents of the University, were united in the effort to keep alive a taste for at least one branch of natural science, and succeeded in enlisting others in its cause.

The first lectures given at Oxford on Mineralogy, which was then as a study not accurately distinguished from Geology, were, it is believed, those delivered by Sir Christopher Pegge, then Regius Professor of Medicine; and although it may not be possible, either from written records or from the personal testimony

* From the Anniversary Address of the President of the Geological Society of London, Feb. 19, 1858. Quart. Jour. Geol. Soc., vol. xiv, Part 3.

of any one now living, to form an accurate opinion of the merits of those lectures, it may be fairly assumed that they were not destitute of attractiveness, as the same individual delivered long afterwards lectures on Anatomy, remarkable for an elegance and a fluency of diction which have caused them to continue fresh in the recollection of many. Sir Christopher Pegge was succeeded by Dr. Kidd, who for several years gave courses of lectures at Oxford on both the allied sciences, Mineralogy and Geology, and collected around him a knot of persons interested in similar pursuits, who formed themselves into a little club of Oxford Geologists. This club included amongst its members the late Dr. Buckland, the two brothers Conybeare, the late Rev. Philip Serle, of Trinity College, afterwards Rector of Addington, Oxford, and many others, who, though less vigorously devoting themselves to geological research, were still, from their eminent qualities and high character, most instrumental in keeping alive the growing interest for the new science, and in raising the character of the club so high, that some of the early members of the Geological Society of London, then in its infancy, amongst whom were the late Mr. Greenough and the present patriarch of our science, Dr. Fitton, were in the habit of paying an annual visit in Whitsunweek to the University, in order to explore, under the guidance of the geologists of Oxford, the physical structure of the rocks in its neighborhood; whilst, on their part, they thus judiciously enlisted local inquirers in the service of general geology.

The venerable Principal of Magdalen College, Dr. Macbride, is the only survivor at Oxford, of this memorable club, and he preserves at an advanced age the vigor of his faculties, and exhibits all his former interest in the progress of learning and of science; but of non-residents, there still survive Archdeacon Hony, now Prebendary of Sarum, and Mr. Philip Duncan, who now resides at Bath: the latter and his brother, Mr. John Grant, were Fellows of New College, were honored by the degree of D.C.L., and were remarkable not only for their love of natural history, but for their zealous support of every philanthropic and scientific object. The Rev. William D. Conybeare was, however, in the first rank of this little body, and stood so high in the estimation of all its members, that Dr. Buckland, when first lecturing as the successor to Dr. Kidd, expressed in the warmest terms his sense of the obligations he owed to him for the information he had imparted on points relating to geology, and his persuasion that it would not have been fitting for him to offer himself to fill the office of lecturer on that subject, had Mr. Conybeare been desirous to occupy it. Let me add here, that another equally eminent individual, the founder of the new school of geology at Cambridge, as Dr. Buckland was of that of

Oxford, has assured me, with a similar frankness, so characteristic of Prof. Sedgwick, that he too looked upon Dean Conybeare as his early master in geology.

In 1814 Mr. Conybeare married, and retired from the University, the scene of his early triumphs, to undertake the quiet work of a country curacy, and nine years afterwards removed to the vicarage of Sully in Glamorganshire, on the presentation of the late Evan Thomas, Esq., his brother-in-law; but, whilst holding the curacy of Banbury and Lectureship of Brislington, near Bristol, he was mainly instrumental, in conjunction with Sir Henry DelaBeche, in founding the Bristol Philosophical Institution and Museum, and it was at that time he received a visit from the great French geologists, M. Elie de Beaumont and M. Dufrénoy, who came for the purpose of acquiring a knowledge of the secondary rocks of England, as a standard of reference for those of France; and he so deeply impressed them, whilst acting as their companion and guide in an exploration of the neighborhood, with a sense of his geological knowledge, that they were prepared on their return to coöperate with Cuvier in obtaining the election of Mr. Conybeare as a corresponding member of the Institute for Geology. Nor must it be supposed that this excellent man neglected his sacred duties whilst storing his mind with the richest treasures of geological research, as it was during his residence at Sully that he delivered, gratuitously, at the request of his friend Dr. Prichard, a course of theological lectures at Bristol College, of which institution he had become a visitor.

In 1836 he left Sully and went to Devonshire, having presented himself to his family living of Axminster, and, whilst there, preached, at the request of the authorities of the University of Oxford, the Bampton Lecture for 1839. The living of Axminster he resigned after a few years, on being called by his friend Bishop Copleston to the care of the Cathedral of Llandaff. Here he continued zealously to carry on the good work of restoration which had been commenced by his predecessor Dean Bruce Knight; and, as at all times in his life, he was ever ready to distribute the rich and varied stores of his mind for the benefit of his fellow-men in whatsoever station of life they might have been. This venerable, much-loved man, and admired philosopher, left Llandaff to attend the death-bed of his eldest son, and, whilst pausing in his return at the house of another son, was stricken with pulmonary apoplexy, and died on the morning of the 12th of August, after an illness of only three hours, in the 71st year of his age.

Such is the general picture of the life of a truly estimable man; and I shall now add to it a very brief notice of his most characteristic works, premising, however, that, even before the

peace of 1815 had opened the Continent to British geologists, Mr. Conybeare had formed, from the imperfect data then within his reach, a sound opinion as to the identity of the Jura limestone with the oolitic formations of England, an anticipation which he had afterwards the gratification, in conjunction with Dr. Buckland and Mr. Greenough, of verifying. The versatility of the genius of Dean Conybeare led him to examine and describe the lesser points connected with organic remains, as well as the greater; a circumstance in which he strongly resembled his friend and fellow-laborer, Dr. Buckland. For an exemplification of this peculiarity of his mind, I shall refer to his paper published in the year 1844, in the second volume of the Transactions of the Society, and therefore one of his early contributions to palæontological science. It was entitled, "On the Origin of a remarkable Class of Organic Impressions occurring in nodules of flint." Mr. Parkinson had described them as "small round compressed bodies, not exceeding the eighth of an inch in their longest diameters, and horizontally disposed, connected by processes nearly of the fineness of a hair, which pass from different parts of each of these bodies, and are attached to the surrounding ones; the whole of these bodies being thus held in connexion." Mr. Parkinson considered that these bodies were the works of polyps, and he therefore classed them with corals of some unknown genera; and Dr. Buckland, who had directed his attention to them simultaneously with Mr. Conybeare, considered that the moulds in which the siliceous casts had been formed were the work of parasitic insects, the thin hair-like appendages having been the passages of entry first made by the insects, and the larger flattened bodies the cavities afterwards excavated, the object of the excavation having of course been to obtain nourishment from the body thus eaten into, whether a shell or any other. This observation of Dr. Buckland was communicated to Mr. Conybeare, but not until he had completed his own researches, and arrived at the same virtual conclusion,—namely, that "these cellules were the works of animalcules preying on shells and on the vermes inhabiting them." In arriving at this conclusion, Mr. Conybeare was guided by the examination of various fragments of shells, still preserved in contact with the siliceous matter which had subsequently been infiltrated into the cavities produced by the boring animal. These appear to have been portions of shells distinguished by a striated texture, and were stated by Mr. Conybeare to resemble in structure the recent *Pinna marina*, as the genus *Inoceramus* does; but in addition to these, Mr. Conybeare found them connected with other shells, and even with an *Echinus* and *Belemnite*. Though Mr. Conybeare spoke with diffidence of his having brought before the Society a paper on such minute palæontology, it cannot

be doubted that the interest connected with the discovery of the existence and workings of minute marine animals at so remote an epoch is of a very high order. The flints and other siliceous deposits of the chalk and other geological epochs, have indeed been striking examples of the effect of judicious investigation in rendering the most obscure objects the means of throwing light upon natural phenomena.

Mr. Conybeare was fully aware of the necessity of studying physical as well as organic phenomena in connexion with geological science; and it is truly surprising how often the intimate connexion of the physical geography of remote epochs with their natural history is overlooked. His description of the landslip which occurred on the coast of Culverhole Point, near Axmouth, in December 1839, was ably illustrated by a series of lithographic plates from the drawings of the present Lieut. Colonel Dawson; and the magnitude of the results was well expressed by the following words: "Although this convulsion can only be ascribed to the less dignified agency of the land-springs constantly undermining the sub-strata, yet, in the grandeur of the disturbances it has occasioned, it far exceeds the ravages of the earthquakes of Calabria, and almost rivals the vast volcanic fissures of the Val del Bove on the flanks of Etna." Without doubt these phenomena are very striking and interesting in themselves: but they become still more so when we reflect as Mr. Robert Mallet has taught us to do, that they ought not to be confined to the existing epoch alone, but should be sought for in the stony records of past ages. The paper on the Hydrographical Basin of the Thames, written with a view to determine the causes which had operated in forming the Valleys of the Thames and its tributary streams, is equally valuable as tending to maintain the value of attending to physical geography in geological investigations. His examination, also, of the Theory of Mountain chains, then recently propounded by M. Elie de Beaumont, as well as his remarks on the phenomena of geology which most directly bear on theoretical speculations, are proofs of the truly philosophical and enlarged view he took of his favorite science.

In noticing the works of Dr. Buckland, I have already detailed the importance of the paper which was compiled by him in conjunction with Mr. Conybeare, on the Bristol and South Welsh Coal-fields; one, as I then observed, of those elaborate and comprehensive papers which were the fitting work of the first pioneers of geological science, and the difficulty of which can scarcely be appreciated in these times when the foundations of the science have been fairly laid, and geologists have only to improve or correct the details. His remarks on the sections of the Antrim and Derry coast were also a conjoint work, and of much interest.

Another and equally remarkable work was that undertaken in conjunction with the late Mr. William Philips, namely, the "Outlines of the Geology of England and Wales," as it may be considered the first systematic work on the subject; and, though geology has been since more specialized and studied in minuter detail, this work will always be regarded as a striking proof of the ability and knowledge of the authors.

It was, however, in 1821 (April 6) that Mr. Conybeare communicated to the Society that remarkable Palæontological paper which excited so much interest at the time, and established in the most satisfactory manner the propriety of establishing a new genus of *Reptilia*, forming an intermediate link between the *Ichthyosaurus* and Crocodile, to which Mr. Conybeare gave the name of *Plesiosaurus.*

The discovery of immense vertebræ of oviparous quadrupeds in the Lias near Bristol had attracted the attention of Mr. Conybeare, who quickly recognized the difference between those belonging to the *Ichthyosaurus* and others, which evidently in his opinion were portions of a different animal. With a singular acumen and rare sagacity, he placed the detached vertebræ in their proper position, and finally established his new genus, for which he adopted the name *Plesiosaurus*, as expressing its near approach to the order Lacerta.

For the whole group of animals which approximate, on the one hand, to the crocodiles in general organization, and yet have been provided with such specific organs as were necessary to enable them to live, at least principally, in the sea, Mr. Conybeare proposed the name *Enaliosauri*, as a classic appellation for the whole order; and he observes of the genera composing it, that even the *Ichthyosaurus*, which recedes most widely from the forms of the Lizard family, and approaches nearest to those of fishes, exhibits in its osteology a beautiful series of analogies with that of the crocodile, and which widely remove it from fishes.

In this paper he then described in the minutest detail the osteology of the *Ichthyosaurus*, and exhibited a knowledge of anatomy which excited the admiration of every one. He then examined with equal care the relics of the new genus, which, although at that time not complete, were sufficient to enable Mr. Conybeare to conclude that the vertebral column recedes from that of the *Ichthyosaurus* in all the points in which the latter approaches to the fishy structure, and that the invertebral substance must have been disposed much as in *Cetacea;* and that, from the locking together of the articulating processes, it must have had much less flexibility than in the *Ichthyosaurus* or in fishes. In examining also such portions of the paddles as could be arranged in order, he comes to a similar conclusion in another direction, namely, that the paddles of the *Plesiosaurus* are inter-

mediate in character between those of the *Ichthyosaurus* and the Sea-turtles; and thus in every respect he laid a sound foundation for his new genus.

It is to be remarked that this paper was given as the joint production of Mr. Conybeare and Sir Henry De la Beche, to whom Mr. Conybeare most liberally ascribed a full share of the merit of the discovery; but, allowing Sir Henry every praise for his assistance in that discovery and in all the geological details, I believe the sagacity and skill exhibited in the osteological details and reasonings have always been ascribed to Mr. Conybeare.

In a second paper, read May 3, 1822, Mr. Conybeare was enabled to describe much more fully all the relations of the genera *Ichthyosaurus* and *Plesiosaurus*, from the discovery of other remains, both of the *Ichthyosaurus* and *Plesiosaurus*, by his coadjutor Sir Henry De la Beche. A very minute examination of the teeth, especially, enabled him to point out that those of the *Icthyosaurus* were more intimately related to the teeth of the crocodile than to those of other *Lacertæ* (an opinion then at variance with the opinions of some anatomists), whilst at the same time, in other respects, the analogy was in the other direction, for Conybeare observes, "in pursuing, however, the history of the teeth of the *Ichthyosaurus* to the last stage, we quit these analogies with the crocodile, and arrive at another point wherein the *Ichthyosaurus* resembles the other *Lacertæ*, in common with many of the *Mammalia:* this is the gradual obliteration of the interior cavity in old age, by the ossification of the pulpy nucleus." In conjunction with Sir H. De la Beche he brought up the number of species to four, determined from the teeth; and in his further consideration of the genus it is right to notice the following remarks, proceeding from him after noticing a difference in one character of the fossil crocodile, when compared with the recent, as stated by Cuvier:—"I am persuaded from every circumstance, that a much nearer approximation to the structure of the older lacertian genera will be found in the fossil than in the recent crocodiles: interesting links in the chain of Saurian animals will be thus supplied, and it will probably be found that many of the points in which the *Ichthyosaurus* differs from the recent type are only instances of its agreement with the fossil."

The researches of Sir H. De la Beche had not at this time led to the discovery of a complete skeleton of the new genus *Plesiosaurus;* but additional portions of it were found, including a very perfect dental bone of the lower jaw, whilst a tolerably perfect head was discovered by Mr. Thomas Clarke in the Lias of Street, near Glastonbury.

The investigation of these new relics of the *Plesiosaurus* led Mr. Conybeare to the following conclusion: "On the whole then, the manner in which the ribs of the *Plesiosaurus* articulate

throughout, by a single head, to the extremity of the transverse processes of the vertebræ only, the structure of the humero-sternal parts, and the characters derived from the head, approximate this animal most nearly to the *Lacertæ*. By its teeth, on the other hand, it is allied to the crocodile; while its small nostrils and multarticulate paddles are features in which it resembles the *Ichthyosaurus*." This able paper he concluded with words characteristic of his natural modesty, after pointing out the difficulty of rendering anatomical details at once scientifically accurate and yet attractive to a general audience: "I need not add how much these difficulties will be increased in the hands of a writer who must acknowledge that, while intruding on the province of the comparative anatomist, he stands on foreign ground, and, using almost a foreign language, is frequently driven to adopt an awkward periphrasis, where a single word from the pen of a master would probably have been sufficient."

However some may at the time have been inclined to throw doubts upon the deductions of Conybeare, the ability and accurate discrimination of the author were publicly recognized by the great Cuvier, who hastened to advocate his admission to the French Academy as a Corresponding Member for the science of Geology; and I am sure that all living palæontologists will follow the example of the late well-known, and at that time so highly respected, Mr. Clift, in recognizing the great merits of Dean Conybeare, and considering him one of the principal founders of the science in this country.

At the present moment it would be tedious and unnecessary to pass in review the whole of the long series of Mr. Conybeare's geological works, nineteen in number; and I shall point your attention therefore solely to that able "Report on the Progress, Actual State, and Ulterior Prospects of Geological Science," which he presented to the British Association in 1832, at its meeting in Oxford, in which he treats the subject with the combined powers of the scholar and man of science, pointing out the remarkable analogy in the views of Leibnitz to those of many modern speculators on physical geology; the opinions of Hooke in respect to the hypothesis of the elevation of our continents by volcanic agency; the masterly observations of Smith, first made known in 1799, which, although not the first to originate the doctrine of a regular distribution of organic remains, yet reduced to certainty and order what had been before vague and conjectural; the gradual rise of the Tertiary Geology from its foundation in the admirable "Memoir on the Basin of Paris," by Cuvier and Brongniart, published in 1811; the establishment of the Geological Society in 1808, and the labors of all the great men connected with it, including, amongst many others, Greenough, Buckland, Sedgwick, Fitton, Murchison, De la Beche, Phil-

lips, Scrope, Daubeny, and Lyell, together with those of foreign geologists, including the great Von Buch and Boué. That Report alone is sufficient to prove his masterly acquaintance with the history of his favorite science, and with all its bearings, whilst it marks the liberal spirit with which he entered into all geological inquiries. The advance of geology since that Report has been enormous; and, if a period of twenty years from the publication of Cuvier and Brongniart had done so much in raising Tertiary Geology to a high position, may we not say that the result of the next twenty-five years has been still more remarkable, and has richly rewarded the continued and judicious researches of some of our most distinguished geologists, such as Lyell, Forbes, Prestwich, and Austen, whilst the elevation to which the Silurian system has arrived by the persevering exertions of Murchison is a monument of progress which we can scarcely hope will be equalled in that peculiar branch of geology in future times.

The zeal of Dean Conybeare for geology never forsook him; and when obliged to visit Madeira on account of the health of his youngest son, he visited the Peak of Teneriffe, and studied the other volcanic phenomena of the neighboring islands. How deeply must we regret that his last days were embittered by sorrow for the death of another son, from whose funeral he was returning at the time of his death! But so excellent a man, prepared for death by the strict performance of every Christian duty during life, requires not the commiseration of those who survive him; although all who recollect his air of gravity and of sincerity, which always made his words effective in commanding attention and respect, and in bringing home conviction to the minds of his hearers, must feel how heavy a loss we have experienced.

2. Alcide D'Orbigny.

Alcide D'Orbigny, Professor of Palæontology at the Museum of Natural History in the Jardin des Plantes, was remarkable for the vast magnitude, as well as for the interesting character of his palæontological works, intended as they were to embrace the whole field of geology in France, and, of course, comparatively to notice the relations of the ancient inhabitants of all portions of the earth whilst describing those of his native country. Mr. D'Orbigny was born at Couëzon (Loire Inférieure), and was, in succession, Travelling Naturalist for the Museum of Natural History, Secretary of the Natural History Society, Member of the Central Commission of the Geographical Society, Assistant of M. Cordier in the Geological Course, and latterly occupant of the chair of Palæontology which had been created expressly for him. He was a Knight of the Legion of Honor.

Mr. D'Orbigny commenced in 1826 his travels for the Museum, under the auspices of the government. As a student at Rochelle, D'Orbigny passed his earlier years on the sea-shore, and employed much of his time in examining the natural productions thrown ashore by the waves. Before he had attained the age of twenty-two, he presented to the Academy a work which was attended with great success, as the committee appointed to examine it reported that, from the great number of new species he had made known, he deserved to be placed in the first rank of original observers. In 1826 he proceeded, as Travelling Naturalist for the Museum, on a voyage to South America, where he explored, with equal perseverance, courage, knowledge, and success, Brazil, Buenos Ayres, the frontiers of Patagonia, and the Republics of Chili and Bolivia, from the shore of the Pacific Ocean to the centre of the continent: he afterwards went through the Republic of Peru, and, when he returned to France, had visited all that portion of the earth from the 11th to the 12th degree of latitude, and from the Pacific to the Atlantic Ocean.

As the product of this voyage, Mr. D'Orbigny brought home most extensive collections and manuscripts, numerous drawings of objects of natural history, and everything necessary to illustrate the geography, the languages, the ethnology, and archæology of this part of America: historical manuscripts, thirty-six vocabularies of the American language, a collection of animals containing 7000 species, of which many were new, and one of about 2300 species of plants, as well as much information respecting the geology of the countries he visited, were amongst the results of his labors, and were embodied in the great work entitled, "Voyage dans l'Amérique du Sud," published under the sanction of the Minister of Public Instruction. He also superintended the publication of another work, "Voyage pittoresque dans les deux Amériques;" and his labors were appreciated by the Geographical Society of France, which awarded him its annual prize in 1836. As an active, intrepid, and persevering traveller, he had thus made his way over an immense extent of country, from Brazil and Peru to Patagonia, in eight successive years, sometimes navigating previously unknown rivers, sometimes penetrating virgin forests, resting on the loftiest plateaux of the Andes, or in the plains of Patagonia, frequently finding himself amongst contending tribes, and being obliged to take part in their conflicts.

Alcide D'Orbigny, who had thus studied nature under all its varied forms, now devoted himself to a task not less deserving of the admiration of posterity, as he thenceforth consecrated his life to the study of Palæontology, a science which had only sprung into existence in the nineteenth century, and which has

already enabled the geologist to study the ancient natural history of the several epochs of the earth's history, and to determine by that clue the true *relative* age of the mineral deposits with which the fossil relics of animals and plants, long since removed from observation as existing genera and species, are associated. It has been justly said that what he succeeded in accomplishing in this new branch of science, was so vast as to be almost beyond the intelligence, and, I may add, the physical powers of any one man; and, as a proof, I will at present mention his Foraminifera of Cuba, of the Canaries, of Meudon near Paris, and of Vienna; his studies on the Crinoids, his "Prodrome de Paléontologie," his "Course of Stratigraphic Geology," and especially his "Palæontology of France," which has extended to fourteen volumes, and contains 1400 plates of French fossils.

Alcide D'Orbigny was removed by death only four years after he had been chosen Professor at the Jardin des Plantes, and before he had had time to complete his great palæontological works, though it is believed that he has laid the foundation of a palæontological collection worthy of France. I have on a former occasion spoken of the nomenclature introduced by him into geology, which, although founded in great measure upon that previously adopted in England, deserves, from its simplicity, and in many respects its euphony, the ready reception which it has obtained on the continent. In respect to his great work on the Palæontology of France, I am aware that many English palæontologists consider that he has been sometimes too hasty in the creation of new species; but this error, I fear, is common to a large portion of palæontologists, and will not be entirely remedied until naturalists have made their comparisons, not with drawings, but with actual specimens. Making, however, every deduction on that account, the works of Mr. D'Orbigny must ever stand forth as a memorial of the most persevering industry and of a high order of intellect, in confirmation of which opinion I will briefly but more particularly notice some of his numerous works.

In doing so I shall principally confine myself to the notice of such works and opinions of D'Orbigny as affect materially either the philosophy or the practice of geological science. Such papers as his Monograph of the new genus of Gasteropods to which he gave the name *Scissurella*, or his description of two species of the genus *Pterocerus*, found in the Jurassic limestone of La Charente Inférieure, or his essay on the beaks of fossil Cephalopoda, in which he divides the Rhyncholites into two divisions, belonging to different genera, one being the beaks of *Nautili*, and not of *Sepiæ*, as had been before supposed,—an idea supported by the anatomical description, by Professor Owen, of

the *Nautilus Pompilius,*—or his note on the genus *Caprina*, his tabular view of the class Cephalopoda, his memoir upon a second living species of the family of Crinoids, to which he gave the generic name *Holopus*, and many other of his papers, are sufficient proofs of his great knowledge of, and accurate judgment upon, almost all branches of natural history; but others speak the language of a philosopher on such subjects.

Every one will doubtless remember the different opinions which were once entertained on the true position, amongst organized beings, of the Foraminifera, some naturalists having, from the resemblance of form, allotted them to the Cephalopoda. After a careful examination of the animal portion as well as of the shelly covering of these minute, often microscopical, bodies, he disproved the earlier notion of their alliance to the Cephalopods, which he had himself at first adopted, and proposed a general classification of the Foraminifera, founded upon the form of their shells, placing them amongst the Radiata, close to the Polyps. In this great and important inquiry he described and figured 118 new species from the Island of Cuba and from the Antilles, and afterwards 43 species from the Canaries, of which 33 were peculiar to those islands. Nor was it to living Foraminifera that he confined his attention, as he described and figured 54 species from the white chalk of the Paris basin, all, with the exception of three or four, new, and then again those which had been discovered by M. von Hauer in Austria, ending by the following statement of the geological distribution of Foraminifera:

	Genera.	Species.
Palæozoic strata	1	1
Jurassic strata	5	20
Cretaceous strata	34	280
Tertiary strata	56	450
Existing epoch	68	1000

So that it would appear that the genera and species were few in number and simple in structure at first, and increased both in number and complexity of structure from formation to formation, until they had obtained their maximum of development in the present seas. D'Orbigny even considered that this gradual advancement from simple to compound was more distinctly manifested in these minute beings than in any others, and that they are in consequence the best fitted for determining with precision the relative ages of geological strata. The following ten living genera, *Gromia, Rimulina, Conulina, Vertebralina, Caudenia, Pavonina, Robertina, Cassidulina, Uniloculina*, and *Cruciloculina*, M. D'Orbigny named as not having been as yet discovered in a fossil state; and he gave the following view of the climatal distribution of the Foraminifera, which also cannot fail to be

very suggestive to the palæontologist. Torrid Zone, 375 species; Temperate Zone, 350; Frigid Zone, 75: so that, as in Mollusca, the seas of hot climates are more productive of species of Foraminifera than those of colder regions.

D'Orbigny traces the history of these bodies from their first discovery in 1731 to the present time; and as a proof of the importance of the office they may have played in the formation of some geological strata (the houses of Paris and the pyramids of Egypt being in part built of rocks composed of Foraminiferous shells), he states that little more than an ounce in weight of the sand of the Antilles yielded 480,000 of these shells. D'Orbigny concluded, from his examination of the Foraminifera of the Paris basin, that they had lived in a hot climate, and had not been subjected to the wearing action of any current.

In explaining the distribution of the Foraminifera of South America, Mr. D'Orbigny points out how varied the groups are, under the influence even of chorographic differences,—the Foraminifera of the southern shores of the Pacific differing from those of the southern shores of the Atlantic, and both from those of the equatorial region of the Antilles, from which fact he deduces the conclusions, that in the same sea, and in connexion with the same continent, different fauna may exist at very small distances from each other; and further, that Tertiary basins, although different in their fauna, may have been formed simultaneously, just as the material deposits are necessarily widely different in character at localities by no means very remote. Unquestionably the reasoning is good, and equally applicable to the geological deposits of all ages of the world.*

In his essay on the distribution of the Acetabuliferous Cephalopoda, he states, in reference to their present distribution, that 15 out of 16 genera are found in hot countries, 10 in temperate regions, and 6 only in cold; and he also concludes, from his inquiries, that these forms are more complicated as they inhabit hotter regions, and further, that it is probable the fossil genera

* It must not be assumed from my remarks on D'Orbigny's labors in the *Foraminifera*, that I consider him to have arrived at his final results *per saltum*. Far from it, as in 1826 his object, as so well explained by Férussac, was simply to separate the microscopical *Cephalopoda*, as he then considered them to be, from the Siphoniferous genera with which they had been confounded. De Haan had previously proposed such a separation, and founded upon it his *Siphonoides* and *Asiphonoides*; but D'Orbigny felt that there were other differences, and therefore proposed his more distinctive term *Foraminifera*. His "Prodromus," published at that time, was founded upon this view of the subject, and remained the standard of classification until Desjardins, in 1835, gave many reasons, deduced from careful observation, for separating the *Foraminifera* from the Mollusca entirely, and forming of them a totally distinct class, to which he gave the name *Symplectomères*. Desjardins therefore gave the impulse which has since led to the correct classification of these microscopical but most interesting animals, which have been shown, by the examination of the deep-sea soundings of the Atlantic, to be as active now as in ancient epochs in laying the foundations of future strata.

lived under a high temperature. Taking account of this view of the subject, it is interesting to observe the other statement of M. D'Orbigny, that the Acetabuliferous Cephalopoda appeared first in the Jurassic formation, when they were represented by the *Belemnites* and six other genera, including the existing genus *Sepia* and three other living genera, simultaneously with the vast numbers of *Ammonites;* that all disappeared except the genus *Belemnites* in the Cretaceous epoch, being represented, however, by different species; and that in the Tertiary strata, the *Belemnites* disappeared entirely, being replaced by the genus *Sepia* appearing for the second time, and the genus *Beloptera*, which appeared, only to pass rapidly away, as it is no longer a living genus. These are unquestionably very remarkable facts; and have on the one hand a tendency to support the doctrine which M. D'Orbigny so strongly supports, of the destruction of one creation and the production of another again and again at successive epochs, whilst, on the other, they may induce a pause in the decision of the palæontologist, as it seems difficult to conceive that any such genera as *Sepia*, *Sepioteuthis*, &c., could have been created so far back as the Jurassic age, and then have totally disappeared, to be *again created* in the Tertiary and existing epochs. I must again maintain that it is more natural to conceive that the link of connexion between the dead and the living has been kept up, although hitherto the region of their habitation, during the long period of time elapsed, has been veiled from observation.

I shall not attempt further to follow the able author of no less than fifty distinct treatises, some of vast magnitude and interest, and all full of ingenuity and knowledge; but I may notice him as the author of that nomenclature which is gaining ground rapidly; and in doing so I will quote, as illustrative of his method, the distribution of the Bryozoa-Cellulina, which he thus details:—

		Genera.	Species.	
Terrains Crétacés.	Etage Néocomien	1	1	593 species.
	— Aptien	1	1	
	— Albien	1	1	
	— Cénomanien	11	26	
	— Turonien	9	17	
	— Sénonien	54	547	
Terrains Tertiares.	Etage Suessonien	3	5	109
	— Parisien	12	24	
	— Falunien	40	75	
	— Subapenin	4	5	
Existing Fauna.		58	312	312

The Bryozoa-Centrifugina, which form the other division of the class, he discovered in almost all the geological formations, and he gives their numbers thus:—

	Genera.	Species.
In the Palæozoic	10	66
—— Triassic	0	0
—— Jurassic	32	93
—— Cretaceous	130	480
—— Tertiary	32	101
—— Existing epoch	26	80

And he concludes from the whole that there were *three centres* of development of the Bryozoa, the first two composed of B. Centrifugina alone,—namely, one in the Carboniferous stage of the Palæozoic, and one in the Bathonian of the Jurassic,—and the other composed of both orders, Cellulina and Centrifugina, in the Senonian stage of the Cretaceous.

Having now, I trust, enabled every one to form a correct judgment of the great and varied abilities of Mr. D'Orbigny, in aid of whose researches the Society has twice awarded the proceeds of the Wollaston Fund, I will close my remarks with the following passage from the report of Messrs. Brongniart, Dufrénoy, and Élie de Beaumont, on his "Geology of South America," as it conveys a sentiment in which all our members will, I am sure, cordially concur:—

"The author's reserve, in treating upon a subject so vast and difficult, cannot but be approved, although no one can fail to perceive that the memoir of M. D'Orbigny has enriched science with a great number of new facts and with many ingenious speculations. New observations may hereafter lead to a modification of some of his theoretical views; but the merit will always be his of having considered a vast subject from a point of observation so elevated as must necessarily cause it to command attention, and lead the way to still further progress. We therefore propose to the Academy that it should express to the author the high satisfaction it has experienced in contemplating the indisputable advancement which has been made towards a knowledge of the geology of South America, by his courageous and persevering researches:"—let me also add, towards a knowledge of the geology of all parts of the earth; for his great works on the Palæontology of France deserve such commendation.

Art. XII.—*Caricography;* by Prof. C. Dewey.

(Continued from vol. xxiv, p. 48, Second Series.)

No. 254. *Carex Geyeri*, Boott, Lin. Trans., vol. xx, p. 118, Kunze, No. 55. Illus. Car. Boott, No. 98, Tab. 105.

Spica unica androgyna, superne staminifera cum squamis oblongis obtusis, inferne pistillifera; fructibus 1–4 alternis subremotis tristigmaticis obovatis triquetris ore integris et albis inferne productis vel stipitatis glabris, squamam oblongam magnam amplectentem cristatam subæquantibus; culmis superne foliaceo-bracteatis.

Culm a foot high, slender, sometimes scabrous above, with stiff radical leaves as long as the culm and rough on the edges; spike single, an inch or more long, upper half inch staminate and slender-cylindric with long and oblong close whitish scales; the lower part pistillate, with 1–4 large fruit, which are separate and subremote or scattered, sometimes 4 fruit along an inch, often fewer and nearer, the upper fruit sometimes one-fourth inch below the staminate; stigmas 3; pistillate scale broad, oblong, clasping, more or less awned, and a little longer or shorter than the fruit.

Mountains of North America; C. A. Geyer, in honor of whom it was named; also, Duffield's Ranch, Sierra Nevada; Dr. Bigelow, Explorations for Pacific Railroad, vol. iv, p. 163.

This species is related to *C. phyllostachys*, Meyer, which has a shorter and ovate fruit with a scale very long and leaf-like. Its association is with *C. Wildenovii*, Schk.

No. 255. *C. decidua*, Boott, Lin. Trans., vol. xx. p. 119. Illus. Car. No. 157, p. 63, Tab. 170.

Spicis 3–6 cylindraceis erectis gracilibus atro-purpureis; suprema staminifera brevi-pedunculata clavæ-formi interdum basi vel medio pistillifera, squamis oblongis obtusis vel obovatis doro-albi-nervosis instructa; pistilliferis 1–5 distigmaticis sessilibus bracteatis, superioribus 1–3 brevibus parvis contiguis interdum geminatis apice staminiferis, inferioribus 2 longioribus subremotis foliaceo-bracteatis; fructibus oblongo-ovatis vel obovatis rostellatis inferne teretibus deciduis nervosis ore integris, squama oblonga obtusa dorso pallida subduplo brevioribus.

Culm a foot or more high, triquetrous and quite rough on the edges above and leafy towards the base, and sheathed, rather slender; staminate spike single, short-pedunculate, often pistillate at the base and sometimes in the middle, longish and club-form, with staminate scales oblong, obovate, obtuse and white on the keel; pistillate spikes 1–5, erect, sessile, rough-bracteate,

sometimes 1–3 short approximate to the staminate, and staminate also at their apex, and two longer and remoter below, sometimes only 2 or 3 pistillate spikes of which the upper is near the staminate and the other more remote; stigmas 2; fruit oblong, ovate, or obovate, short rostrate, entire at the orifice, nerved and tapering below, but scarcely stipitate; pistillate scale oblong obtuse pale on the back, and near twice the length of the fruit.

First found in Terra del Fuego; afterwards with the preceding, by Dr. Bigelow, as noticed in the same work. My specimens are from the latter locality.

NOTE.—As the authority of Willdenow led to the confounding of *C. paleacea*, Wahl., with *C. crinita*, Lam., it is important to say *how* the confusion has been ascertained and the mistake corrected. This has been done by Dr. Boott in his "Illustrations of the Genus Carex," a title so unpretending of a magnificent work on Caricography, finely characterized by Prof. Gray in the July number of this Journal.

Wahlenberg gave a specimen of his *C. paleacea* to Mr. Tuckerman, who passed it to Dr. Boott. It proved to be the *C. maritima*, Vahl., and of course, was very far from *C. crinita*, Lam. But our botanists had long before found a plant, which was figured by Schk. as one form of *C. crinita*, and they were thence led to call another apparent form of it, var. *paleacea*, as being the *C. paleacea*, Wahl.; Schk. supported the same mistake. Having thus corrected the mistake of Willd. and error of Wahl. and of Schk., Dr. Boott saw that our *so-called* var. *paleacea* is the real *C. crinita*, Lam. Hence, the other form of it must be the variety, if it belongs to it. But Dr. Boott shows the manifest difference between them, and gives to this the name *C. gynandra*, appropriated to it by Schweinitz as early as 1824. The true *C. crinita*, Lam. then is ascertained, and another species is named. This and its synonyms will be as follows:—

No. 256. *C. gynandra*, Schw., An. Tab. Boott Illus. Car., No. 48, Tab. 50. *C. crinita*, Schk., fig. 125, Tab. Eee, not of Lam. Dew., Sill. Journ., vol. x, p. 270, and Am. Auth. Var. *gynandra*, Schw., and Tor., and others.

With the change of names in Sill. Journ., vol. x, p. 270–1, as indicated above, the description there is definite and adequate, as shown by the specimens sent by me to Dr. Boott.

I have not often seen the peduncles of the lower spikes so long as on Dr. Boott's figure. The spikes too are generally larger, often somewhat ventricose in the middle, with more staminate flowers at their tapering summit, and more densely fruited than those presented, or more like fig. 125, Schk. The geographical range is greater than shown by Dr. Boott's speci-

mens, and extends over much of New England, New York, and far into Pennsylvania.

The separation, long desired by some, of this species from *C. crinita*, has thus been accomplished.

It is thus made easy to settle the synonyms of *C. crinita*, common in American authors.

C. crinita, Lam. Boot, Illus. Car., No. 47, Tab. 49. Schk., fig. 164, Tab. Ttt. Muh. Gram., p. 229. *C. leonura*, Wahl. Sartwell Exsic. Car., No. 58. Var. *paleacea*, Dew., Sill. Journ., x, p. 270–1. Tor. Mon., 401. Carey and Gray's Manual, p. 549.

Changing the names in Sill. Journ., vol. x, p. 270–1, as already indicated, the description there will distinguish the true *C. crinita*. Dr. Boott's figure fully and finely shows this species, and is far superior to fig. 164, Schk., above mentioned, though I had in 1826 referred this species to it. The long and slender, whipform, densely flowered spikes, with the long and rough-awned pistillate scales, and the roundish or obovate or oval fruit, short-beaked and ventricose, form distinctive characters. They describe *C. crinita*, Lam., there called var. *paleacea*.

Var. *minor*, Boott, as above.

Spikes smaller and shorter, 1–2 inches long, often nodding, or erect, rather loose-flowered, commonly with a long lanceolate and rough-awned scale:

These characters are plain on my specimens of this variety.

This species differs from *C. gynandra*, Schw., in having smooth, and not scabrous sheaths of the leaves, more slender and longer pistillate, spikes more closely fruited, as well as in the fruit and scale.

Dr. Boott's enthusiasm, position and extensive collection of Carices, as well as his acute discrimination, enable him to make other corrections, some of which at least will much interest our students of this vast and difficult genus. I advert to one more, viz., the proper designation of the species so long known over the country as *C. anceps*, Muh. The proper extension of the species is another consideration on which there may be difference of opinion. It was so named by Muhlenberg, in letters to Willdenow, on account of its *two-edged* peduncles of the spikes, and was published by Willd. under that name, though Muh. afterwards published it as *C. plantaginea*, and yet referred it to Schk.'s figure of *C. anceps*. In 1826 I referred it to the synonym, *C. striatula*, Mx., without any consideration of the priority of the name. Several varieties of it were described, and much later Mr. Carey, in Gray's Bot., named one of them (under *C. anceps*) var. *striatula*, very appropriately. In 1857, Dr. Gray, in his Manual of Botany, referred it to *C. laxiflora*, Lam., and, in 1858, Dr. Boott published the reasons for this reference in his Illustra-

tions, with the synonyms and several varieties. There is much propriety in presenting some of the changes, observing at the same time that this species had been called in our country, to 1857, *C. anceps*, Muh.

C. laxiflora, Lam., 1789, not of Schk.
Boott, Illus. Car., No. 87, Tab. 89, 1858.
Gray, Man. Bot., p. 524, 1857.
C. heterosperma, Wahl., No. 67, 1803.
C. striatula, Mx., vol. ii, p. 173, 1803.
C. anceps, Muh., Letter to Willd.
Willd., vol. iv, p. 278, 1805.
Schk., Tab. Fff., fig. 128, 1812.
C. plantaginea, in part, Schk., Tab. Kkkk, fig. 195, 1812, not Lam.
Muh. Gram., p. 242, 1817, not Lam.
C. anceps, Muh. Dewey, Sill. Journ., vol. x, p. 36, 1826.
Tor. Mon. Cyp., p. 414, 1836, and Am. Auth., var. *patulifolia*, Dew. Carey Ed. 1, and Man. Bot., 1857, and var. *plantaginea*, Boott, both Schk., fig. 195.

This case shows us the principal cause of the numerous synonyms in Caricography, viz., their being named by different botanists in different places and unknown to each other. In so large a genus, embracing more than eight hundred species, in all quarters of the globe, this multiplication of names may easily occur. This species was named by authors in different parts of the world, who knew not those already given. Hence, all the names were correct and legitimate, except the reference of this species in Muh. Gram. to *C. plantaginea.* Interesting as is the correction by Dr. Boott, the point attained shows only the author of the original or first name.

Again; where the so-called variety requires as long, or nearly as full a description, as the species itself, there is no objection to giving it the rank of a species, till it is proved that both forms are produced from the same seed or the one changes into the other in growing. In the well known varieties, as some have called them, this proof has not been attained in one case of a hundred. Some have been called varieties and so described for years, when they have been raised to the place of species, and continue to hold their rank. Besides the instance of *C. gynandra*, already noticed, there are others equally obvious and certain.

For these reasons, it is difficult for me to adopt two of the varieties of this species in Dr. Boott's splendid "Illustrations," viz., *C. styloflexa*, Buck., and *C. blanda*, Dew. Indeed, it needs but little extension of the specific description to comprehend two or three other and admitted species.

ART. XIII.—*On the Variable Illuminating Power of Coal Gas;* by WILLIAM E. A. AIKIN, Prof. Chem., &c., University of Maryland.*

(Read before the American Association for the Advancement of Science, at the Baltimore Meeting, May, 1858.)

IN common with a large number of our citizens, my attention was directed some short time since, to a somewhat sudden, inexplicable and enormous increase in the amount of our quarterly bills for gas consumed; an increase equal at times to an advance of a hundred per cent over the corresponding quarter of the preceding year. As it would have been absurd to suppose a simultaneous derangement of all the meters over an extensive district, it was obvious that the difficulty could not lie in any error in the registry of the gas, but in its illuminating power, necessarily requiring the consumption of a greater bulk of gas to produce a given quantity of light. Feeling curious to know how this difference could have occurred, I set myself to work to ascertain, if possible, what causes could be acting to diminish the illuminating power of the gas.

It has long been known that the quality of the gas produced from the fat coals is very materially influenced by the circumstances of the decomposition. In the elaborate experiments made some years ago on a most extended scale by Hedley, the British Engineer, as detailed in his report to a committee of the House of Commons, we find this subject most satisfactorily discussed. Below a cherry red heat the products obtained by heating coal in close vessels contains hardly any illuminating material. At that temperature it is furnished most freely, but after having been formed is liable to decomposition, involving a loss of carbon by contact with any highly heated surface in passing through the apparatus. Such decarbonization increasing with the degree of heat, with the extension of the red hot surface, and with the time of contact. Again, the duration of heat is most important, the best gas coming over during the first hour, the quality rapidly deteriorating, until at the expiration of four hours the product is worth very little to the consumer, and after five hours may be considered as worthless. But the bulk of such worthless gas that can still be obtained by pushing the process to completion is very considerable, equal sometimes to $\frac{2}{5}$ of all that passes over.

How far any neglect in the observance of the precautions required to produce a proper illuminating gas, may explain the result the public have no means of knowing. All that we know

* The title of the above paper was accidentally omitted when the list of papers read before the Association was published in the July No. of this Journal.

is that the manufacturers furnish an article which they say is the right article and prepared in the right way, and possessing an illuminating power varying from 14 to 17 candles. That is, their engineer reports, that on trial with a photometer, at stated times, the gas burning from a jet, consuming five cubic feet per hour, gives an amount of light equal in the average to that of 15 patent candles six to the pound. The patent candle being ostensibly a mixture of spermaceti and wax. Assuming as true all that is claimed by the manufacturers, it can still be shown that the gas even if properly made and correctly tested may be and is furnished to the consumer in a condition of greatly diminished illuminating power, compelling the consumption of a greater bulk to obtain the required light and consequently swelling the record of the meter and the sum total of the quarterly bills. In my trials to determine the specific gravity of our gas by weighing a globe previously exhausted and then filled with it, I obtained a result ranging from ·570 to ·580 somewhat below that given as characterizing good gas. But in reality I attach very little importance to this result since the mere specific gravity of such a complex mixture as coal gas can hardly be relied upon to determine its commercial value.

Although good gas certainly has a higher specific gravity than poor, yet the difference could not be taken to represent the true difference in value since the principal components of the mixture hydrogen, carbonic oxyd, light carburetted hydrogen, olefiant gas and other still heavier hydrocarbons having specific gravities, widely different, might vary somewhat in their relative proportions sufficient to affect the illuminating power, without at the same time and to the same extent affecting the specific gravity. The action of chlorine in removing the olefiant gas and other more dense hydrocarbons, the principal light giving materials of the coal gas, showed a per centage of these substances never exceeding 10 per cent. But not having time at the moment to guard against all sources of error in the process, laid it aside. My attention was principally directed to the simple inquiry to what extent will the illuminating power of the gas be impaired by keeping it in contact with water for noted periods. That it does deteriorate when thus kept, or when kept in contact with oil or even close vessels has been long known.

Dr. Ure tells us that gas from oil when first made and with a specific gravity of 1·054 will give the light of one candle when burned from jets consuming 200 cubic inches per hour. But keep the gas three weeks and then to get the same light from the same burner you must supply 600 cubic inches per hour. He adds that with coal gas the deterioration appears to be more rapid. For if such gas when first made will give the light of one candle by the consumption of 400 cubic inches per hour,

when kept four days will require the consumption of 460 cubic inches per hour to give the same light. My first attempt to obtain some definite results began on the evening of the 8th ultimo, when I filled a large receiver from the street main and placed it on the shelf of the pneumatic trough, the next evening I filled a second one and put it alongside of the first, the following evening I filled a third receiver, and still the following evening, the 11th inst., I filled a fourth receiver. On the evening of the 12th I was thus provided with four jars of gas, one of which had been standing 24 hours or one day over the pneumatic trough, this I will call No. 1; another, No. 2, had been standing two days; No. 3 had been standing three days, and No. 4 had been four days in contact with the water. The diminution in volume by such exposure was indicated by a receiver graduated to cubic inches into which I introduced 130 cubic inches of gas on the evening of the 8th; on the evening of the 12th this had lost about 10⅜ cubic inches, indicating a loss of about 8 per cent. of the original bulk.

The effect produced on the illuminating power of the gas by the loss of volume became at once apparent as I proceeded to contrast the value of the flames furnished by the contents of the several receivers, 1, 2, 3, and 4. I used for this purpose the ordinary photometer arrangement, taking the relative intensity of the shadows produced, as a measure of the relative intensity of the light. The candle employed for the comparison was the patent candle already referred to, and the burner was the kind known as fish tail burner, which had been previously guaged, and known to consume a trifle more than 5 cubic feet per hour with the average maximum pressure of the gas works. I need hardly add that the burner was the same in all the trials, and occupied exactly the same position. The burner and the screen on which the shadows fell were not moved at all during the experiments. The only adjustment wanted was to bring the candle nearer to or father from the screen, and by beginning with the most luminous gas the adjustment became simply a gradual withdrawal of the candle.

The capped receiver from which the gas was passed floated freely in a large glass jar, supported in an erect position by the perpendicular sides of the jar, its own weight, with all attachments, making a difference of level between the water around it and that within equal to 3½ inches, a little exceeding the ordinary evening pressure in the gas pipes. This difference of level, and consequently the pressure on the escaping gas, was kept uniform by the spontaneous sinking of the receiver as the gas was consumed, a flexible tube communicating between the stop of the receiver and the gas burner. This arrangement gave me a steady, equable flame, which continued perfectly uniform long

enough to enable me, after a few trials, to note, very exactly, its true value. The results as first obtained were too startling to be at once believed, but subsequent repeated trials satisfied me that they were very close approximations to the truth. The first trial was with the gas from the street main, which I found equal to 10·71 candles. The same gas, transferred from the pipe to the capped receiver, and burned immediately, gave exactly the same power, 10·71 candles. Gas No. 1 was next used, and found equal to only 3·50 candles; Gas No. 2, after standing two days, gave the light of 3·20 candles; Gas No. 3, three days old, was equal to 1·90 candles; and Gas No. 4, four days old, gave the light of 1·75 candles—these quantities representing the average of repeated trials.

It thus appears that the illuminating material of our coal gas is so rapidly abstracted by suffering it to remain in contact with water, that the same volume of gas which to-day will give me the light of nearly 11 candles by standing until to-morrow will give the light of only 3½ candles, and if left standing four days will give the light of only 1¾ candles, while the only means left to the consumer to get the light he requires from this deteriorated gas is to burn more of it, as we have all been doing through the past winter. If we now take into account the well known fact that gas of less illuminating power has less density, and that gas of less density passes more rapidly through a given aperture than gas of greater density, we have another cause operating to increase the consumption. In Hedley's experiments the Argand burner which gave the light of 25 candles when supplied with 3 cubic feet per hour of gas from Welsh cannel coal, with a specific gravity of ·737, required no less than 7½ cubic feet per hour to give the same light, from the same burner, when the gas was made from the Newcastle coal and had a specific gravity of only ·475.

Again, as we diminish the illuminating power of the gas we increase its heating power, and this necessarily brings with it a higher temperature given to the burners, a higher temperature given to the gas passing through them, and again an increased rapidity in the flow. It is thus manifest that the public are placed in a peculiarly unfortunate position, since all the mistakes that are likely to occur in the process of manufacture are mistakes that must inevitably increase the bills of the consumer and the profits of the manufacturer. If the workman fails to raise the heat with proper rapidity, if he overlooks a retort and allows the heat to continue a little too long, if towards the close he allows the heat to rise a little too high, the result is inevitable the product is deficient in illuminating power. Or if on any one day a little more gas is produced than is legitimately required, the surplus remains in the gasometer to vitiate the supply of to-

morrow. To what extent this vitiating action operates may be inferred from the fact that I have never been able to obtain from the gas of our pipes an illuminating power equal to the minimum of that reported by the engineer of the gas company. In my trials the power has varied from that of 13 candles down as low as that of 9 candles, instead of ranging from 14 to 17 candles.

This difference is perfectly intelligible if we assume the last quantities to represent the value of the gas when first made, and my results to represent its value as delivered to the consumer.

In conclusion I would merely add that the difficuly suggests its own remedy. And that would be to have a standard of quality established by the proper authorities, taking the illuminating power as the basis of the calculation, and then to have the requirements of such standard insured by a nightly examination, if necessary on the part of some one entirely disconnected with the manufacture. In other words the photometer can be made as available and as valuable to the consumer of gas as the hydrometer is to the spirit merchant; as he distinguishes with his instrument in any mixture, between the spirit he wishes to buy and the water he is unwilling to pay for, so the consumer of gas can distinguish with the photometer between the true illuminating material and the worthless heat producing gases, hydrogen and light curburetted hydrogen, that make up the bulk of the ordinary coal gas.

ART. XIV.—*On the Dynamical Condition of the Head of a Comet;* by Professor W. A. NORTON.

IT is proposed, in the present article, to give the mathematical theory of the development of the nebulous envelope of the head, and the tail of a comet, from the nucleus; under the combined action of a repulsive force exerted by the nucleus, and a repulsive force exerted by the sun—each of these forces being supposed to vary inversely as the square of the distance from the centre of the repelling mass. So far as I am aware, no attempt has hitherto been made to develope the idea of a dynamical condition of the head of a comet into a mathematical theory, based upon precise numerical laws.

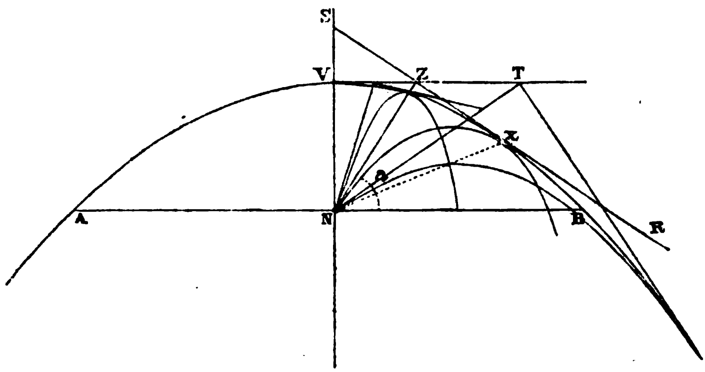
The hypothesis that a projectile force is in operation, combined with a repulsive action, or even with a gravitating force only, will also be briefly considered.

Let us first suppose cometic matter to be expelled from all points of the surface of the nucleus, on the side toward the sun, and in directions normal to the surface, regarded as spherical. As the nucleus is very small, in comparison with the nebulosity

of the head, the error will be slight if we regard it as a mere point, and conceive the nebulous matter to be repelled in all directions from this point. At the same time it must be observed that, for each expelled particle, the central point of repulsion is below the point of emission a distance equal to the radius of the nucleus. Again, as the rectilinear dimensions of the head of a comet are small as compared with its distance from the sun, we may, without material error for our present purpose, regard the repulsive force of the sun as constant.

Let N (fig. 1) be the nucleus, regarded as a point, NS the direction of the sun, and AB a line perpendicular to NS, which

1.



we will regard as the line of demarcation between the head and tail. Suppose a particle to be emitted in the direction NZ, and let the angle of projection, ZNB $= a$. Also let $p =$ acceleration due to excess of repulsion of nucleus over its attraction, at the surface of the nucleus; $k =$ opposing acceleration, from sun's repulsive force; and $r =$ radius of nucleus, or the distance of the point of emission from the centre of repulsion, wherever this may be. We will first undertake an approximate investigation, by disregarding the effect of the recess of the particle from the line NZ upon the repulsive force of the nucleus. This amounts to supposing that the centre of repulsion moves along a line perpendicular to NZ, at the same rate that the particle recedes from NZ.

Decompose the sun's repulsive force into two components,—the one along NZ, and the other perpendicular to it. The former will be $k \sin a$, and the latter $k \cos a$. Denoting by z the distance passed over by the receding particle, in the direction NZ, in any interval of time; and by v the velocity at that distance, we have,

$$\left(\frac{pr^2}{z^2} - k \sin a\right) dz = vdv.$$

Integrating, $$-\frac{pr^2}{z}-k\sin a\,.\,z+C=\frac{v^2}{2}.$$

If we suppose the initial velocity to be zero, $v=0$, when $z=r$, and

$$-\frac{pr^2}{r}-k\sin a\,.\,r+C=0, \text{ or, } C=\frac{pr^2}{r}+k\sin a.$$

Whence, $$pr^2\left(\frac{1}{r}-\frac{1}{z}\right)-k\sin a\,(z-r)=\frac{v^2}{2}; \text{ or, } pr^2\left(\frac{z-r}{rz}\right)-k\sin a\,(z-r)=\frac{v^2}{2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Let Z= greatest distance passed over in the direction NZ, and we have $$\frac{pr}{Z}-k\sin a=0; \text{ or, } Z=\frac{pr}{k\sin a} \quad . \quad . \quad (2)$$

This value of z is the distance NZ, X being the point where the orbit is tangent to the line ZX, perpendicular to NZ. Putting $a=90°$, we get for the distance to which a particle will recede from the nucleus, when emitted in the direction NS,

$$H=\frac{pr}{k} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

But, by equ. (2), $Z\sin a=\frac{pr}{k}=H$; also $Z\sin a=Z\sin NZV=NV$; hence NV=H, and the point Z will fall on VT, drawn through V, at the distance H from N, and perpendicular to NS.

To find X, the point of tangency, resume equ. (1); and, since remote from the nucleus r may be neglected in comparison with z, we have $$\frac{dz^2}{dt^2}=v^2=2(pr-k\sin a\,.\,z) \quad . \quad . \quad (4)$$

Whence, $$dt=\frac{1}{\sqrt{2}}\cdot\frac{dz}{\sqrt{pr-k\sin a\,.\,z}}=\frac{1}{\sqrt{2pr}}\cdot\frac{dz}{\sqrt{1-\frac{k\sin a}{pr}z}}$$

Integrating, $$t=\frac{1}{\sqrt{2pr}}\cdot\frac{\left(1-\frac{k\sin a\,.\,z}{pr}\right)^{\frac{1}{2}}}{-\frac{1}{2}\,\frac{k\sin a}{pr}}+C$$

Or, reducing, $$t=-\frac{\sqrt{2pr-2k\sin a\,.\,z}}{k\sin a}+C \quad . \quad . \quad (a)$$

This formula is quite accurate for determining any portion of the interval of time sought, for the beginning of which z is large in comparison with r, and as the motion is far more rapid in the vicinity of the nucleus than at a distance from it, we may obtain pretty nearly the whole interval of time, from N to X, by supposing z, at the beginning, to be several times r; but, on this

supposition the formula gives nearly the same value, as when z is made equal to zero. Therefore let $t=0$, when $z=0$, and we have

$$C=\frac{\sqrt{2pr}}{k\sin a}; \text{ and}$$

$$t=\frac{\sqrt{2pr}}{k\sin a}\left(1-\sqrt{1-\frac{k\sin a.z}{pr}}\right) \quad . \quad . \quad (5)$$

For the point X, $z=\frac{pr}{k\sin a}$, and $T=\frac{\sqrt{2pr}}{k\sin a}$ . . (6)

To verify this value of T, I have made another calculation, by dividing the time into two intervals. The first extends to the instant of time when the distance becomes equal to the $\sqrt{\frac{k}{p}}$ part of the whole distance, Z; during which the motion may be regarded as very nearly uniform, with an average velocity equal to $\sqrt{pr}$. The calculation for the remaining interval was made by the above equation (a). The result obtained is $T=\frac{\sqrt{2pr}}{k\sin a}\left(1+\frac{1}{5}\sqrt{\frac{k}{p}}\right)$. This differs from the above determination, by only $\frac{1}{85}$, in the case of the comet of 1811, and about $\frac{1}{20}$ in the instance of Donati's Comet.

To find ZX=X, we have $X=\frac{1}{2}k\cos a.T^2=\frac{1}{2}k\cos a\frac{2pr}{k^2\sin^2 a}=$

$$\frac{pr\cos a}{k\sin^2 a}=\frac{pr}{k\sin a}.\cot a \quad . \quad . \quad (7)$$

But $ZX=ZN\times\cot ZXN=\frac{pr}{k\sin a}.\cot ZXN$; hence $ZXN=a=ZNB=NSZ$. (Fig. 1.) Thus NX=NS; and the point of tangency, X, of the path of any particle to the line ZR, lies in a parabola, which has N for its focus, and V for its vertex.

As the orbits of all the particles are tangent to this parabola, the paraboloid generated by revolving it about its axis will be, approximately, the bounding surface of the head of the comet.

To ascertain the form of the orbit traced, on the present supposition, by any particle, resume the value of t, as given by equ. (5); also take the value of t given by equation $x=\frac{1}{2}k\cos a.t^2$. We thus get

$$\frac{\sqrt{2pr}}{k\sin a}\left(1-\sqrt{1-\frac{k\sin a}{pr}z}\right)=\sqrt{\frac{2x}{k\cos a}}$$

Squaring, $\frac{2pr}{k^2\sin^2 a}\left(1-\sqrt{1-\frac{k\sin a}{pr}z}\right)=\frac{2x}{k\cos a}$ (approximately)

Reducing, $\left(1-\frac{k\sin{}^2a}{pr\cos a}x\right)^2=1-\frac{k\sin a}{pr}z$

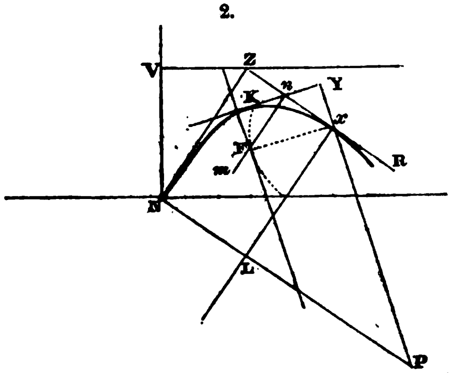
Transposing coordinates to point X, we have, $x=\frac{pr\cos a}{k\sin{}^2a}-x'$,

and $z=\frac{pr}{k\sin a}-z'$; substituting and reducing,

$$\frac{k\sin a}{pr}\text{tang.}^2a.x'^2=z',\ \text{or},\ x'^2=\frac{pr}{k\sin a}\cot{}^2a.z' \quad . \quad . \quad (8)$$

This is the equation of a parabola; the diameter through X makes an angle β with XR (fig. 2) determined by the equation $\cot\beta=\frac{2X}{Z}$; or by laying off LP=2X, and joining P with X. The parameter of this diameter=X.cot a sin β.

2.



To find the focus and vertex lay off on the diameter produced the distance $XY=\frac{\text{parameter}}{4}.\cos{}^2\beta$, draw YK perpendicular to the diameter; the vertex will be on this line. Through the point n where this line crosses the tangent XZ, draw nm perpendicular to XZ, and with a radius $=\frac{\text{parameter}}{4}$ describe a circle around X as a centre; the point F in which this circle cuts nm is the focus. Drawing FK parallel to XP, we have the axis and the vertex. The parameter of the axis $=X\cot a\sin\beta.\sin{}^2\beta=X\cot a\sin{}^3\beta=Z\cot{}^2a\sin{}^3\beta$ (by equs. (2) and (7)).

In this investigation it is virtually supposed that the nucleus moves along the line NL, perpendicular to NZ, at the same rate that the particle recedes from NZ. This may seem to be a rough approximation except in the case of a large angle of emission; but, with a certain restriction soon to be stated, the results obtained are in fact a close approximation to the truth. The reason is that the repulsive force of the nucleus produces the greater part of its effect while the particle is in its vicinity, and at a distance from it, where the change of direction and the difference between NZ and NX has become considerable, it is exceedingly small in comparison with the sun's action. To test the accuracy of our results, let us investigate the distance that

the particle will recede in the direction NZ, upon a different and extreme hypothesis; viz., that it is projected from a point at a distance $2r$ from the centre of the nucleus, with a velocity equal to that acquired in passing from the distance r to the distance $2r$, and that the repulsion of the nucleus acts in the direction NX, which, as we have seen, is inclined to NZ under an angle equal to the complement of a. The differential equation for finding the velocity in the direction NZ, will be

$$\left(\frac{pr^2}{z^2}\sin a - k \sin a\right) dz = vdv.$$

Integrating, $-\frac{pr^2}{z}\sin a - k\sin a . z + C = \frac{v^2}{2}$.

Putting V= velocity at distance $2r$,

$$C = \frac{V^2}{2} + \frac{pr^2}{2r}\sin a + k \sin a . 2r$$

Whence, $$\frac{v^2}{2} = k \sin a\,(2r - z) + pr^2 \sin a\left(\frac{1}{2r} - \frac{1}{z}\right) + \frac{V^2}{2} \quad . \quad . \quad (9)$$

To find V^2, we have $v'\,dv' = \frac{pr^2}{z^2}dz$, or $\frac{v'^2}{2} = -\frac{pr^2}{z} + C$.

$C = \frac{pr^2}{r}$; thus $\frac{v'^2}{2} = pr^2\left(\frac{1}{r} - \frac{1}{z}\right)$. Which gives $\frac{V^2}{2} = \frac{pr}{2}$, $V^2 = pr$, and $V = \sqrt{pr}$.

Substituting in equ. 9, we have

$$\frac{v^2}{2} = k \sin a\,(2\,r - z) - \frac{pr\,(2r - z)}{2z}\sin a + \frac{pr}{2}.$$

Putting second member $=0$, we obtain

$$Z = \frac{pr}{k \sin a} - \frac{pr}{k \sin a}.\frac{1}{2}(1 - \sin a) \text{ (nearly)} \quad . \quad . \quad . \quad (10.)$$

The second term is small in comparison with the first, except for the smaller angles of emission. Taking $a = 45°$,

$$Z = \frac{pr}{k \sin a} - 0{\cdot}14\,\frac{pr}{k \sin a}.$$

We accordingly have, in general, $Z = \frac{pr}{k \sin a}$ (nearly). This is the same result that was obtained by the first investigation. That it can differ but little from the truth may be seen by comparing $V = \sqrt{pr}$, with the greatest possible velocity that the repulsive energy of the nucleus could impart to a particle, if unopposed by any force, and acting through an infinitely great

distance. The expression for this maximum velocity is $\sqrt{2pr}$; greater than V only in the proportion of 7 to 5. At the point V (fig. 1) the repulsive force of the nucleus is less than that of the sun, in the same proportion that NV is less than r, the radius of the nucleus. In the case of the great comet of 1811 this ratio was nearly as 300 to 1. Unless a comet comes very near the sun, the repulsion of the nucleus, at the outer surface of the head, is therefore so small in comparison with the sun's repulsive energy, as scarcely to have any sensible effect.

We may therefore suppose that when any receding particle reaches the tangent point X, (fig. 2), it continues on its course, subject to the sun's action alone. The preceding investigation would not, in general, apply with sufficient accuracy to the orbit continued beyond this point. The trajectory that we readily obtain on the supposition just mentioned, becomes, however, materially modified when a returning particle passes in the vicinity of the nucleus. The repulsion of the nucleus will in this case deflect the particle into a curve convex to the nucleus. When the distance is too great for this effect to be produced, the repulsion will still have the effect to diminish, more or less, the curvature of the orbit.

The trajectory at the remoter distances from the nucleus may also be obtained, by the ordinary theory of projectiles, if we regard the particles as projected from the point where its orbit becomes parallel to AB, and with the velocity which it there has. As the angle of emission, a, becomes quite small, this conception would lead to less accurate results.

We have hitherto supposed the particle, emitted from the surface of the nucleus, to have no initial velocity. If we suppose it to be projected with any velocity V, this velocity may be regarded as having been acquired in moving from a point at a distance $\frac{r}{n}$ from the centre of the nucleus; and proceeding with the investigation as before, we obtain in place of equ. (2)

$$Z=n\frac{pr}{k\sin a} \quad . \quad . \quad . \quad (11)$$

From which it appears that the effect will be to increase the value of Z, in the ratio of n to 1; without, therefore altering the form of the head of the comet. The present supposition is equivalent to conceiving the nucleus to be concentrated into a sphere whose radius is $\frac{r}{n}$, and that the particle leaves its surface without initial velocity.

Let us now suppose, for the moment, that the particle is projected from the nucleus, and is subject only to the *attraction* of

the nucleus, and the repulsion of the sun. Let g= acceleration due attraction of nucleus, at its surface; or, what amounts essentially to the same, the excess of the attractive over the repulsive acceleration. We now obtain

$$Z = \frac{V^2}{2\,k \sin a} - \frac{gr}{k \sin a} \quad . \quad . \quad . \quad . \quad . \quad (12)$$

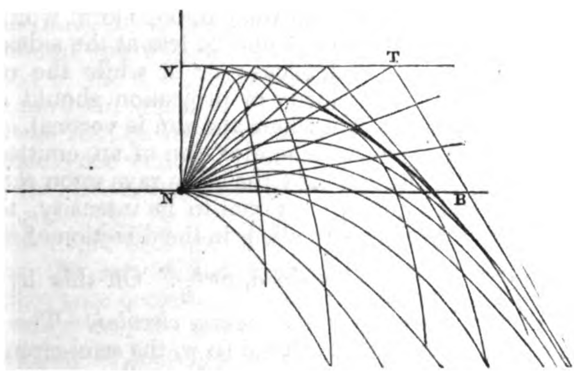
If we suppose $g = 0$, we have

$$Z = \frac{V^2}{2\,k \sin a} \quad . \quad . \quad . \quad . \quad . \quad (13)$$

which is of the same form as equ. (2).

In view of what has now been established we may conclude that, if the force of repulsion is of the same intensity, on all sides of the nucleus, the outer surface of the head of a comet differs but little from a paraboloid of revolution, having its focus at the nucleus and its vertex at the point V, (fig. 1) to which the particles are expelled in direct opposition to the sun's repulsive force. We see also that the paths of the individual particles are very nearly parabolas, having the positions and dimensions indicated on p. 90. Or at least this is sensibly true, from the nucleus to the tangent point X. Fig. 3 shows a number of these orbits, corresponding to various angles of emission.

3.



Such, on the present theory, is the actual limiting surface of the head. The form and extent of the surface, *as visible to the observer on the earth*, must differ more or less from this; for in the first place, at the actual boundary the line of sight touches the surface, and it is not until it falls within it and traverses a larger extent of luminous matter, that a sensible impression is made upon the eye. Again, the apparent form depends upon the obliquity to the axis under which the head is viewed..

Donati's comet, about Oct. 10th, was seen under favorable circumstances for observing the actual form of the head. The line of sight was then inclined under a large angle to the axis of the head and tail. The visible form of the head must also depend upon the various degrees of condensation, or closeness of proximity of the moving particles; and this is dependent upon the relative velocity of the particles following on after each other, and the proximity and intersections of the orbits of different particles. To illustrate, those particles which are ejected more in a direction toward the sun, have very small velocities at the turning points of their orbits; the particles are therefore crowded together there, and the visible surface should differ but little from that of the paraboloid, before mentioned. On the other hand the particles which are emitted from the sides of the nucleus, or under small angles, (a), are constantly moving with increasing velocity, and hence, those which follow each other, in the same path, must separate from one another as they recede. It is therefore only by the proximity and intersection of such separate orbits that the luminosity can be greater at some parts than at others. The tendency of this state of things will be to contract the lateral parts of the head; or in the direction NB, (fig. 3). The apparent surface of the head should therefore lie within the actual parabolic surface, and have the approximate form of an *ellipsoid*,—the form which Donati's comet presented.

A still greater deviation from the parabolic form would result if the energy of the repulsion should be less at the sides than at the anterior portion of the nucleus; or if, while the repulsion remained the same, the velocity of projection should decrease from the front of the nucleus where the sun is vertical.

If we suppose the repulsive acceleration of an emitted particle, to depend upon the action of the sun's rays upon the surface of the nucleus, and to be proportional to its intensity, then the distance to which it will be repelled, in the direction of emission, will be expressed by $\frac{pr}{k \sin a} \times \sin a$, or $\frac{pr}{k}$. On this hypothesis the form of the head would be nearly *circular*. The circular form has in fact often been observed (e. g. the semi-circular disc, or hood, resting upon the nucleus of Donati's comet, after its perihelion passage; also head of Halley's comet, on Oct. 29th, 1835).*

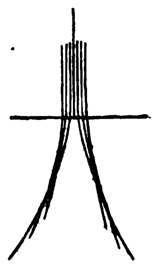
If we adopt the idea that the nucleus exercises no repulsive action; or that its repulsion, if any, is exceeded by its attraction, equ. (12), shows that the form of the head must still be parabolic.

* According to the subsequent theory of the sun's electric action the velocity of emission should, in general, be least at the sides of the nucleus. I conceive also that the repulsion should be least effective, as compared with the attraction, at the sides.

For the first term gives the parabolic form, and the subtractive term varies as $\frac{1}{\sin a}$, which is also the law of variation of the distance between two parabolas having a common focus and axis, estimated in a direction perpendicular to the tangent. The only essential difference between this case and that in which the repulsion is in excess, is that the returning particles which pass in the vicinity of the nucleus will now be attracted by it, and pursue paths more concave toward the nucleus, instead of convex.

A detailed discussion can therefore alone settle definitively the question between these two possible modes of development of the head of a comet from its nucleus. This must be left for another occasion. We will only call attention here to a remarkable luminous appearance that has occasionally been observed behind the nucleus of a comet (e. g. Comet of 1807), which seems to be a striking indication of the operation of a force of repulsion. It consists, apparently, of two jets of luminous matter, issuing from the nucleus, and convex toward each other, like the two branches of a hyperbola. Upon the theory of repulsion, it may be explained by the intersection of the orbits of particles that pass in the immediate vicinity of the nucleus. Those which make the closest approach to the nucleus, will be most deflected from their course. The consequence will be that the trajectory of each particle will intersect those of all the particles that come between it and the nucleus. This curious result is illustrated in fig. 4. It is a case similar to that of caustic curves in optics.

4.

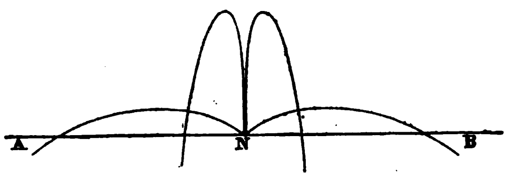


It will be seen on referring to fig. 3, that the particles which are emitted from the portion of the nucleus that lies nearest to the sun, on returning past it go to make up the body of the tail; while those which proceed from the lateral parts, as they are driven away by the sun, finally form the surface of the tail. We would here take occasion to observe that as the angle of emission becomes less, the orbits, as they traverse the head, and are about leaving it, lie nearer together; and rather suddenly separate from each other, when the angle becomes small. This fact is imperfectly indicated in fig. 3. It may be inferred from the fact that the parameter of the parabolic path of the particle continues to increase as the angle of projection diminishes, until it becomes quite small. The peculiarity here noticed affords an explanation of the sudden curved terminations of the luminous disc that formed the central portion of the head of Donati's Comet, as seen in telescopes in October; and of other similar luminous appearances (e. g. Halley's Comet as seen by Struve, Oct. 29th, 1835, and the same on Oct. 22). The natural result,

upon the normal condition of things, would seem to be modified and made more conspicuous, in some instances, by a sudden discontinuance, at a certain point on the side of the nucleus, of the ejection of luminous matter.

I have indicated on a previous occasion (in a paper read before the American Philosophical Society, in 1843) the cause of the curvature of the tail, and of the deviation of its general direction from direct opposition to the sun; on the theory of the particles being separately driven off by the repulsive force of the sun. The theory of the development of the tail is so intimately associated with that of the head—the two appearances being in fact but two different parts of one general phenomenon,—that it will be proper here to notice a particular phenomenon which appears to find its explanation in the views now presented. I allude to the fact so conspicuous in Donati's Comet, and before recognized as a general fact, that the preceding side of the tail was brighter and more distinctly defined than the following side. The phenomenon appears to result from the unequal velocities of different particles as they pass from the head into the tail. This explanation is illustrated in fig. 5. The particles which

5.



recede to a greater distance from the base, AB, of the head, pass it on their descent with much greater perpendicular velocity than those emitted under small angles from the nucleus, and attaining only to a small height above AB. The more rapidly moving particles go to the interior of the tail, the others to the marginal parts. Now the former will pursue a straighter course, as they move away from the head, and one which deviates less from direct opposition to the sun. They will, therefore, cross in succession, or crowd upon the lines pursued by the outer particles on the preceding side of the tail, and separate from those traced by the particles on the other side of the tail. This effect should be more marked as the comet recedes from the sun, and the initial velocity acquired by the central particles, becomes a larger fraction of the velocity imparted to them by the sun. It was finely observed, in the instance of Donati's Comet, about Oct. 10 and 11. As the comet receded from the earth and sun, became less distinct, and our line of sight became oblique to the plane of the orbit, the contrast was less conspicuous, and the wide dispersion of nebulous matter toward the end of the

following side of the tail was no longer noticed. Another cause is in operation, while a comet is receding from the sun, to produce the same results; the central particles, which we have seen have the greater velocity, were emitted from the nucleus before the others which leave the base of the head at the same instant, and therefore arrive with a higher velocity in the direction of the orbital motion of the nucleus. To these may be added another possible cause, in occasional operation; viz: the more copious evolution of luminous matter on the forward side of the nucleus, which, if the comet does not turn upon an axis, has been longest exposed to the sun's action.

In striking confirmation of this explanation we have the fact noticed in the case of Donati's Comet, and of comets generally, that the fainter secondary tails make their appearance at the anterior side of the tail.

Explanation of the observed variations in the size of the Nebulous Envelope of the Head of a Comet, as the Comet approaches and recedes from the Sun.—Many of the variations noticed as having taken place in the length and distinctness of the *tail* of a comet, are merely apparent. For example, when a comet is at a great distance without the earth's orbit its tail is foreshortened; but, for this reason is more distinct than it would otherwise be. The tail of the great comet of 1843 was also very much foreshortened on Feb. 28th, when it was seen in open day; to which supposed fact was attributed, in part, the great brilliancy of the comet before its orbit had been determined. But the variations in the dimensions of the head, to which we here allude are real, and general, if not universal. The facts noticed are that the nebulosity of the head contracts greatly as the comet approaches the sun, and enlarges, in a corresponding degree, as it recedes from the sun. These curious and puzzling facts are but simple consequences of the dynamical theory that has now been developed. On referring to equ. (3) it will be seen that the repulsive force of the nucleus exceeds that of the sun, at the distance of the nucleus, in the ratio of the focal distance NV (fig. 1) to the radius of the nucleus. Unless, therefore the repulsion of the nucleus varies with its distance from the sun, the ratio of these forces must vary inversely as the square of the distance from the sun. The focal distance and all the distances Z, given by equ. (2), should therefore both decrease and increase, according to the same law, as the comet approaches the sun, and recedes from him again. The contractions, observed by Hevelius to take place in Encke's comet, in 1828, as it approached the sun, were greater than would result from this cause alone. The enlargement of the envelope of Donati's comet was also, according to the measurements of G. P. Bond, Esq., of Harvard College Observatory, more rapid than should have resulted simply from

the decrease in the sun's force. We must therefore conclude, from our present stand-point that the matter of the nebulosity is either repelled or projected from the nucleus with an intensity of force that decreases as the comet approaches the sun, and increases as it recedes from the sun. Variations in the amount of luminous matter ejected may also conspire with these variations of intensity of force, to give increased effect. The changes here supposed may seem to be contrary to what would naturally be expected; I can only say in the way of explanation, that they accord with the theoretical views which I have been led to adopt on other grounds, with regard to the process of evolution of nebulous matter from the nucleus, and the nature and origin of the repulsive action.

If we suppose, in the case of Encke's, and other similar comets, that the attraction of the nucleus exceeds its repulsion, the variations in the value of k, as the comet approaches the sun, and recedes from him, will still be attended with an alternate contraction and expansion of the nebulosity. But to explain the full amount of this change, we must suppose the projectile force to vary at the same time.

Determination of the Mass and Density of the Nucleus of a Comet. —If the force of repulsion which we have here considered as exerted both by the nucleus of a comet and the sun, be a property belonging alike to all the particles of the mass of each body, we have the means of readily determining the mass and average density of the nucleus. For equ. (3) makes known the ratio of p to k, and by the law of inverse squares, we may compute the ratio of k to the repulsive acceleration that has place at the sun's surface, which we will denote by K. We then have, to find the ratio of the masses of the sun and nucleus, the proportion

$$p : \mathrm{K} :: \frac{m}{r^2} : \frac{\mathrm{M}}{\mathrm{R}^2}$$

Which gives $\mathrm{M} = \frac{\mathrm{K}}{p} \cdot \frac{\mathrm{R}^2}{r^2} \cdot m$ . . . . . . (14)

I have made the computations for the comets named in the following table, which contains, also, the data used in the calculations.

Name and Date.	Diameter of Nucleus.	Distance N V (Fig. 1).	Distance from Sun.	Observer.
Donati's Comet; Oct. 5th,	400 miles	4410 miles	57,000,000 miles	Bond.
" " Oct. 6th,	800 "	5120 "	57,500,000 "	"
" " Oct. 8th,	1120 "	7720 "	58,500,000 "	"
First Comet of 1811; Oct. 6th,	428 "	63,500 "	106,000,000 "	Herschel.
Halley's Comet, 1835; Oct. 29th,	465 "	25,520 "	64,000,000 "	Struve.
Comet of 1799,	373 "	20,000 "	100,000,000 "	
Comet of 1807,	538 "	30,000 "	95,000,000 "	Herschel.

In the instances of the Comets of 1799 and 1807 the date of the measurements is not known, and accordingly the distance from the sun has only been roughly estimated. The distances given for the other comets are sufficiently close approximations for our present purpose. The true diameter of the nucleus of Donati's Comet cannot exceed 400 miles, as determined on Oct. 5th; but as it is possible that the cometic matter may be ejected from the surface of the apparent nucleus, the calculations have been made from the observed diameters. The results obtained by taking the diameter of nucleus at 400 miles are given at the bottom of the table.

The following table contains the results of the calculations:

Name.	Mass Compared with Sun.	Mass Compared with Earth.	Density (density of water=1.)
Donati's; Oct. 5th,	$\frac{1}{3,891,685,000}$	$\frac{1}{10,400}$	3·8
" Oct. 6th,	$\frac{1}{1,589,806,000}$	$\frac{1}{4,476}$	1·1
" Oct. 8th,	$\frac{1}{778,578,000}$	$\frac{1}{2,193}$	0·75
First Comet of 1811,	$\frac{1}{827,954,000}$	$\frac{1}{2,332}$	13·6
Halley's Comet,	$\frac{1}{890,493,000}$	$\frac{1}{1,945}$	12·6
Comet of 1799,	$\frac{1}{2,671,218,000}$	$\frac{1}{7,524}$	6·3
Comet of 1807,	$\frac{1}{1,136,885,000}$	$\frac{1}{3,202}$	5·0
Donati's; Oct. 6th,	$\frac{1}{3,179,612,000}$	$\frac{1}{8,956}$	4·4
" Oct. 8th,	$\frac{1}{2,180,018,400}$	$\frac{1}{6,154}$	5·9

The densities, although differing considerably among themselves, and possibly, as we shall soon see, too large, indicate that the nuclei of the larger comets are not made up entirely of vapor, or gas. The most probable inference to be drawn from them, is that the nucleus of a bright comet is a body of solid matter, like the earth, more or less covered with water, of which the greater portion is ordinarily in the condition of ice.

If the masses, as above determined, are too large to be admissible, we must then draw the theoretical inference that the matter expelled from the nucleus derives part of its velocity from a *force of projection.* That such a force of projection is in fact sometimes in operation, if the present theory be true, may be seen from the results given in the following table. The calculations are here made for the outer envelope; for which the values of NV were 321,500 miles and 20,000 miles.

Name and Date.	Mass compar'd with Sun.	Mass compar'd with Earth.	Density. (density of water=1)
First Comet, 1811, Oct. 6th,	$\frac{1}{183,598,000}$	$\frac{1}{461}$	68·5
Donati's, 1858, Oct. 2d,	$\frac{1}{758,215,000}$	$\frac{1}{2,136}$	18·7

A similar indication is afforded by the apparent increase in the mass of Donati's comet, from Oct. 5th to Oct. 6th, and 8th, as given in the former table.

When the nucleus appears to be surrounded by a spherical envelope, which is not continued into the tail, as in the case of the great comet of 1811, in the formation of this inner envelope the repulsion of the nucleus may possibly be inoperative. The mass of the nucleus may be determined on this supposition, only by assuming a value for v. We now have equation (12), which, by dividing by r, and taking $a = 90°$, gives,

$$\frac{H}{r} = \frac{V^2}{2kr} - \frac{g}{k}$$

Whence,
$$\frac{g}{k} = \frac{V^2}{2kr} - \frac{H}{r} \quad . \quad . \quad . \quad . \quad (15)$$

This equation gives the ratio of g to k, for any assumed value of V, and the ratio of k to the force of gravity of the sun is made known by the velocity imparted by k to the cometic matter flowing away in the tail of a comet. The calculation may also be made for any supposed value of V, in case the sun's repulsion is inoperative.

As we do not know to what extent a projectile force is in operation, we cannot be positive that the smallest masses and densities we have determined are not too large. In fact, by hypothetically increasing the initial velocity, and diminishing the repulsive force of the nucleus, we may reduce the mass and density to any extent. We may even suppose that the nucleus neither sensibly repels nor attracts the matter projected from it; and conceive the whole effect to result from the projectile force. The velocity of projection, on this supposition would be given by the equation,

$$v = \sqrt{2k(H-r)} \quad . \quad . \quad . \quad . \quad (16)$$

The approximate correspondence that obtains between the densities we have computed, lends support to the idea of a general cosmical repulsion, as a property of all particles of matter, and operating under special circumstances; since it accords with the notion, probable in itself, that the nucleus is made up of liquid, or of solid and liquid matter, like the earth. If subsequent calculations made for the other bright comets should give similar results, this inference would seem almost to be established.

Condition of the Nucleus—Evolution of Nebulous Matter.—On these topics there is only space to give a summary of the speculative notions I have formed. In the first place I conceive the telescopic nucleus of a large comet to consist of an atmosphere of aqueous vapor, or of a vaporous and gaseous atmosphere combined, condensed upon an inner nucleus more or less covered with water, or water partly in the condition of ice. In the case of the telescopic comets this central mass is probably altogether wanting. The vaporous atmosphere of the nucleus experiences vari-

ations of electric excitement under the influence of the sun;—after the same manner that the earth's atmosphere is effected by the sun. That an electric influence is directly exercised by the sun upon the upper regions of the earth's atmosphere, or the *photosphere* of the earth, appears to me to have been established in my later papers on Magnetic Variations, published in former Nos. of this Journal. When repeated electric discharges take place in the higher and rarified regions of the atmosphere of the comet, or of that of the earth, they must have the effect, according to the results of the recent experiments of M. Plücker, to arrange the vaporous matter in columnar masses, coinciding in direction with the lines of magnetic force. We thus have *auroral* columns in the comet's as in the earth's atmosphere. At the magnetic poles of the nucleus these would have a vertical position; and from these points would gradually decline from this position, until at the equator they would lie parallel to the surface. Now as a comet recedes from the sun its temperature falls, the suspended aqueous vapor begins to condense at certain depths in its atmosphere, the electricity thus set free flows in a series of electric discharges, which follow the course of the auroral columns, as soon as they are established. Condensations extending through a considerable vertical depth in the upper atmosphere, would also be attended with electric discharges from the one elevation to the other. It is these electric discharges along these auroral columns that, as I conceive, disengage the particles of aqueous vapor, or nebulous matter so called; and impel them off with a certain velocity. The same discharges bring the expelled particles into a condition to be repelled by the nucleus. How this result may be produced cannot here be adequately explained. As the temperature of the receding comet continues to fall, the process of condensation, and consequent evolution of aqueous vaper, goes on, and the visible nucleus increases in size. It would seem, from the observations of Mr. Bond, on Donati's comet, that large masses appeared to be disengaged at certain intervals. These phenomena may have arisen from the occasional suspension of the electric discharges taking place in the upper atmosphere. This would produce the appearance of the detachment and expulsion from the surface of the nucleus, of a ring of nebulous matter. Luminous phenomena, precisely similar to those here supposed take place in the upper atmosphere of the earth, to which we have given the name of *Aurora Borealis*, and *Aurora Australis;* and probably from the same cause. They are almost uninterrupted at the pole, during the long polar winter, and only at intervals display their coruscations in the skies of the temperate latitudes; where the changes of temperature are less, and the vaporous columns assume a more oblique position. On the other hand while a comet is approach-

ing the sun, its temperature rises, and at the same time its atmospheric electricity increases; condensations of aqueous vapor and their attendant electric discharges are now much less frequent. It thus happens that the evolution of vaporous matter, to form the head and tail, is much less copious before than after the perihelion passage; and increases in quantity for a certain interval of time after it. While these *auroral phenomena*, as they may be styled, are thus subject to great fluctuations, and to sudden interruptions, and are most prevalent in the polar regions* of the nucleus, there would seem also to be an uninterrupted electric discharge, from all points of the nucleus, turned toward the sun, continually detaching particles of aqueous vapor. This should be most abundant at the regions to which the sun is vertical, and where the electric excitement produced by it is the greatest; and may give rise to the hemispherical form of envelope, (see p. 94).

The phenomenon of separate concentric envelopes, or rings, often noticed, shows that the vaporous matter set free, at any time, is not all expelled to the same distance from the nucleus. This would be the case if we were looking down upon the polar regions of a comet whose axis was perpendicular to the plane of its orbit, and the matter was detached in zones from different latitudes. The statement here made will, perhaps, be better understood on glancing at the annexed figure. It would seem also that different intensities of electrical discharge should be attended with different velocities of projection. Upon the theoretical views I have formed these electic variations should also give rise to different intensities of repulsive action, as exerted by the nucleus. Again, if all the particles set free should not be of the same size, the smaller ones would experience the greater repulsive acceleration; provided the material repulsion is of the nature of an impulsive action against the surface of the particle.

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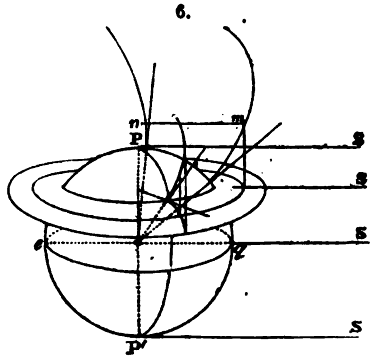


If the speculative notions just presented be correct, the question arises whether the earth may not be regarded, from our present point of view, as a comet; and if so, why do we not see its luminous train. The proper answer to this inquiry would

* It is to be observed that the motion of the nucleus in its orbit, occasions a virtual rotation around an axis perpendicular to the plane of the orbit; so far as exposure to the sun is concerned.

seem to be that the earth is actually, in a certain sense, a comet, and that its luminous train is seen by us in the Zodiacal Light. The nebulous earth-ring contended for by the Rev. Mr. Jones, in explanation of his admirable observations upon the zodiacal light, would seem then, in a modified sense, to have a real existence; instead of being in a condition of statical equilibrium, as supposed, it is in a dynamical condition of perpetual dispersion and renewal.*

Nor is the expulsion of vaporous matter into the surrounding regions of space confined to the nuclei of comets, and the earth. It occurs at the surface of the sun, and perhaps of all the heavenly bodies. It is beautifully seen, as a solar phenomenon, in a total eclipse of the sun; in the *corona*, or halo that encircles the sun concealed behind the dark body of the moon; the *aigrettes* that stream out in various directions, and perhaps also the *rose colored flames* that here and there project beyond the dim circular disc of the moon.

Note.—It would seem that even the visible nucleus of a comet is not in a truly statical condition. It contracts and enlarges with the varying distance from the sun. This may be a mere appearance, arising from the varying luminosity of the photosphere. It is also possible that the inner nucleus, with its atmosphere, may be surrounded by an ethereal atmosphere, which contracts and expands by reason of variations in an impulsive action of the sun, and in the density of the ether of space, in the vicinity of the sun. These remarks may also apply to the entire envelope of Encke's comet, and the complete spherical envelopes sometimes noticed, Spherical envelopes entirely surrounding the nucleus, would also be formed if the cometic matter should be projected from all parts of the nucleus with the same velocity, but with a force insufficient to overcome the gravitating tendency. An apparent spherical continuation of an envelope behind the nucleus, might, perhaps result from the intersections of the orbits of the cometary particles urged past it into space by the repulsive force of the sun.

A more accurate determination of the orbits of the cometic particles will be given in a succeeding No. of the Journal.

ART. XV.—*Review of Hall and Whitney's Report on the Geology of Iowa.*†

THE first volume of the Report on the Geology of Iowa has just been published, and in a style highly honorable to the State. The State embraces much that is of scientific and practical interest, and Professors Hall and Whitney who have had the survey in hand, have accomplished great results considering the time afforded for exploration. The Carboniferous formation is a prominent feature in the geology, and has afforded a splendid collection of

* The vaporous matter which is incessantly streaming off from the sun into remote space, should enhance the brightness of the zodiacal light.

† Report on the Geological Survey of the State of Iowa: embracing the results of investigations made during portions of the years 1855, 56 and 57. By JAMES HALL, State Geologist, and J. D. WHITNEY, Chemist and Mineralogist. Published by authority of the Legislature of Iowa. Vol. I. pp. 724. 1858.

Crinoids for description and illustration. Even the Permian has some representative beds, though discovered too recently—the Introduction states, after the Permian fossils of Kansas had been made known—to be described in detail in this volume. Prof. J. D. Whitney contributes chapters on the Physical Geography, Geology, and Chemical and Economical Geology including Mines,—Prof. Hall, on the General Geology and Palæontology, and A. H. Worthen, (Assistant,) on the Geology of the Des Moines valley and some other parts of the State.

The geological investigations have thus far been confined to the eastern half of the State, the western portion of Iowa, which is equal in area to New York, Massachusetts, Connecticut and Rhode Island put together, not having yet been examined. The work is divided into eight chapters, or divisions, of which the first is devoted to the Physical Geography, the second to some general remarks on the Geology of the Northwest, the third to a review of the Geological formations occurring in Iowa, as exhibited in a section on the Mississippi river, the fourth, fifth and sixth to the detailed Geology by counties, the seventh to the Economical Geology, and the eighth to the Palæontology, the whole work being comprised in 724 pages, with 29 steel and lithographic plates of fossils, a geological map and a diagram of the leadbearing crevices near Dubuque.

In Chapter I, we have a concise view of the topography of Iowa. The State is a vast plain, gradually rising as we proceed from the east towards the west, and from the south, northwards:—the absolute elevations are given from the railroad surveys, when such could be obtained. In this plain the streams have cut deep and narrow valleys, which are bordered by precipitous "bluffs," as they are termed, the river-bottom, bluff and prairie being the three conspicuous features of the topography of the State. The height and steepness of the bluffs decrease gradually from the north towards the south. The course of the tributaries of the two great rivers forming the eastern and western boundaries of the State, the Mississippi and Missouri, is adduced as evidence of the direction of the drainage having been determined by two sets of low and narrow flexures of the strata, one set running in a northwest and southeast direction and the other nearly at right angles to this. The Wapsepinicon is mentioned as a remarkable instance illustrative of this; this river having a length of about 250 miles and draining a valley which is only from eight to twelve miles in width. The "mounds" which break the monotony of the landscape in the lead region, are described as outliers of Niagara limestone, overlying strata of the Hudson river group, and rising in isolated, flat-topped hills, presenting evidence of extensive denundation. These mounds are from 400 to 600 feet above the Mississippi river, and about 200 above the general level of the prairie at their bases.

The prairies, those wonderful treeless and fertile plains, the most marked feature of the Northwest, are described and the subject of their origin, a much controverted question, is briefly discussed. The theories which have, at different times been brought forward to account for the absence of trees in the prairie region are discussed and pronounced to be inadequate. It is attempted in the report to show that the extreme fineness of the particles of which the soil is made up is the predominating cause of this peculiar condition of the vegetation, and some facts are stated which go to confirm this theory. Reasoning from analogy of the smaller prairies to the thickly wooded region of the Upper Peninsula of Michigan, it is inferred; "that the whole region now occupied by the prairies of the Northwest was once an immense lake, in whose basin sediment of an almost impalpable fineness gradually accumulated, under conditions, the discussion of which is postponed to another volume in which the drift phenomena of the Northwest will be taken up; that this basin was drained by the elevation of the whole region, but, at first, so slowly, that the finer particles of the superficial deposits were not washed away, but allowed to remain where they were originally deposited. After the more elevated portion of the former prairies had been laid bare, the drainage becoming concentrated in narrower channels, the current thus produced, aided perhaps by a more rapid rise of the region, acquired sufficent velocity to wear down through the finer material on the surface, wash away a portion of it altogether, and mix the rest so effectually with the underlying drift materials, or with abraded fragments of the rock in place, as to give rise to a different character of soil in the valleys from that of the elevated land. This valley soil, being much less homogeneous in its composition, and containing a larger proportion of coarse materials than that of the uplands, seems to have been adapted to the growth of forest vegetation; and in consequence of this, we find such localities covered with an abundant growth of timber."

"Wherever there has been a variation from the usual conditions of soil, on the prairie or in the river-bottom, there is a corresponding change in the character of the vegetation. Thus, on the prairies we sometimes meet with ridges of coarse material, apparently deposits of drift, on which from some local cause, there has never been an accumulation of fine sediment: in such localities we invariably find a growth of timber. This is the origin of the groves scattered over the prairies, for whose isolated position and peculiar circumstances of growth we are unable to account in any other way."

At the close of the chapter on Physical Geography, a review is given of the meteorological observations which have been made in different parts of the State by different observers. From

a comparison of these some light is thrown on another question which has been discussed without having been satisfactorily answered, namely: What is the difference between the climate of the Eastern and Western States on the same parallel? It appears that while there is but little difference in the mean temperature of the *year* on the Atlantic coast and in the Mississippi valley, in the same latitude, there is a perceptible tendency to extremes in the mean of the *seasons*, the summers being hotter and the winters colder, as we go farther west. The annexed table (from p. 33) will serve to illustrate this statement.

				Temperatures.		
Locality,	Latitude.	Year.	Spring.	Summer.	Autumn.	Winter.
West Point, N. Y..	41° 23′	50°·7	48·7	71·8	53·2	29·7
Fort Armstrong, Ill.,	41 30	50 ·3	50·5	74·1	51·7	24·9
Council Bluffs,	41 30	49 ·3	49·3	74·7	51·4	21·7
Utica, N. Y.,	43 06	45 ·7	44·5	66·5	47·3	24·5
Prairie du Chien,	43 05	47 ·6	48·7	72·3	48·3	21·2
Potsdam, N. Y.,	44 40	43 ·6	42·9	66·3	45·4	19·8
Fort Snelling, Min.,	44 53	44 ·6	45·6	70·6	45·9	16·1

In the geological portion of the Report, we notice the following matters as of more especial interest.

The members of the geological series developed in Eastern Iowa, all belong to the Palæozoic system, and include groups of strata from the Potsdam Sandstone up to the coal measures. The existence of the Permian in the central portion of the state is inferred from the presence of large masses of gypsum overlying the coal measures, but in connection with which no fossils have as yet been discovered. The range and extent of the formations is exhibited on the geological map accompanying the Report, a glance at which will be more satisfactory than an attempt at description. It may simply be noted that the general trend of the formation is northwest and southeast, and that the dip being to the south and west, the traveller, in passing over the State from northeast to southwest, crosses successively higher groups. There appears to have been but little disturbance of the strata since their deposition, and no igneous or metamorphic rocks are known to exist within the limits of the State.

The Silurian series, as it is developed in the Northwest, is made up of alternations of sandstones, dolomites, limestones, and shells. The order of succession, lithological character and thickness of the different members which are recognized in Iowa, may be seen in the annexed table, arranged in an ascending order:

Name of Group.	Lithological character.	Thickness.
Potsdam Sandstone,	Pure silicious sandstone,	250–300 feet.
Lower Magnesian Limestone, (Calciferous Sandstone of N. Y. Rept.)	Dolomite,	250 "
Upper, or St. Peter's Limestone,	Pure silicious sandstone,	80 "
Trenton, or Blue Limestone,	Alternation of slightly argillaceous limestones and shells, with pure limestones,	100–120 "

Name of Group.	Lithological character.	Thickness.
Galena Limestone,	Dolomite,	250–300 feet.
Hudson River Group,	Impure silicious shells and thin limestone bands,	80–100 "
Niagara,	Dolomite,	250–300 "
Le Claire Limestone, not recognized except on the Mississippi river,	Dolomite,	?
Onondaga Salt Group,	Dolomite, a few thin outliers, only recognized on the Miss. river.	

In general there is shown a thinning of the members above the calciferous sandstone as compared with the series in New York, and a disappearance of some of them. A few particulars with regard to the various groups are here added.

Potsdam Sandstone.—The very great thickness of this formation, which has been shown to exist in the Lake Superior region, is limited to the vicinity of the trappean rocks. Proceeding southwesterly from the copper-bearing range, we soon find the conglomerate to have disappeared, and have no evidence in Iowa and southern Wisconsin of the existence of more than 400 feet at any one point, while the mean development is probably not over 250 or 300 feet. The exposures of this rock are very limited in Iowa, but it covers considerable surface in Minnesota, and still more in central Wisconsin. Bands or intercalated masses of conglomerate are almost entirely wanting in the sandstone; these, as well as the lines of oblique lamination, appear to be confined to the vicinity of the igneous rocks. There is no member of the series more persistent, both in lithological and palæontological characters in the lower sandstone; it has been traced from lon. 73° to lon. 104°, exhibiting everywhere the same granular silicious character and characterized by the same organic forms, and we have, up to this time, no evidence of the existence of organic remains below this formation.

Lower Magnesian Limestone.—This is a mass of dolomite, having a thickness of from 225 to 250 feet, about 200 of which are nearly pure, crystalline dolomite, containing from one to ten per cent. of silicious sand, mechanically intermixed; the remaining 25–50 feet are beds of passage into the sandstone below, consisting of mingled and alternating sandstone and dolomite. Fossils are extremely rare in this member of the series; a few have been observed in Wisconsin in a very imperfect state of preservation, but none in Iowa.

Upper or St. Peter's Sandstone.—This repetition of the sandstone underlying the lower magnesian, is also remarkable for its persistence in lithological character and thickness over a great extent of surface. From La Salle, in Illinois, where it makes its appearance in a low axis of elevation, underlying the coal-measures unconformably, to St. Paul in Minnesota, a distance of over 400 miles, this sandstone hardly varies more than ten feet from its normal thickness of about 80 feet, which indicates a remark-

able uniformity in the physical conditions prevailing at the time of deposition of this comparatively thin mass. The fact that this sandstone is so persistent in its thickness and lithological character; that it consists of almost chemically pure quartz, in the form of grains of minute, but uniform size, with crystalline facets; that it contains no pebbles or fragments which can be recognized unmistakably as being of foreign or detrital origin, are noticed as giving plausibility to the supposition that it was a chemical precipitate, rather than the result of the mechanical disaggregation of pre-existing quartzose rocks. No fossils have been found in this sandstone.

Trenton Limestone.—Under this head is designated the series of beds between the Upper Sandstone and the Galena limestone, which may be subdivided into two portions: *a*, the buff limestone, an impure dolomite, containing from ten to twenty per cent of sand and clay; it is from fifteen to twenty feet thick, and is, in the vicinity of the Mississippi river, quite destitute of fossils. It is succeeded, in the ascending order, by *b*, the blue or Trenton limestone proper, a series of calcareous and calcareo-argillaceous layers, lime unaccompanied by magnesia appearing here for the first time in the series, the whole having a thickness of from 70 to 80 feet. For the first time, also, we find traces of organic life abundantly disseminated through the rocks, a fact not without significance in its relations to the absence of magnesia noticed above. Many of the layers, and shaly partings between the compact calcareous beds, are crowded with forms either identical with, or closely allied to, those which characterize the Trenton limestone in its extension from New York through Canada and on the northern shores of Lakes Huron and Michigan, and as far west as the Mississippi, along a line of outcrop some 1500 miles in extent.

Galena Limestone.—The passage from the Trenton limestone into the next succeeding member of the series, the Galena limestone, is not an abrupt one; on the contrary, there are, in many localities, several alternations of calcareo-magnesian and purely calcareous layers, indicating that the change of conditions which resulted in the deposition of the highly crystalline dolomite which overlies the Trenton was not effected at once, nor without occasional partial returns to the former state of things. The Galena limestone, as usually developed, is a rather thick-bedded, light greyish, or light yellowish grey, dolomite, distinctly crystalline in its texture and usually rather coarse-grained. The more crystalline portions frequently contain cavities lined with small crystals of brown spar, and the rock is remarkable for the irregularity with which it weathers, leaving picturesque outliers, with castellated forms, like watch-towers, or the half-ruined walls of ancient fortified cities. The quantity of insoluble matter in

this dolomite is very small, not usually exceeding two or three per cent; it consists almost entirely of quartzose sand. The fossils of the Galena limestone are closely allied to those of the Trenton, although, in the lead-region, certain ones, such as the *Receptaculites* and *Lingula quadrata*, which are characteristic of the Galena limestone, are not found in the underlying blue. The fossils of the Galena are all in the form of casts with the exception of those in which the shell originally consisted of *phosphate* of lime instead of the *carbonate*, as was the case with the *Lingula*; it appears, therefore, that the chemical changes which the rock has undergone since its deposition have been such as to remove the substance of shells consisting of the carbonate of lime, but to leave the phosphate untouched. Another interesting fact in connection with the palæontology of the Galena limestone is, the discovery in it of a single specimen of *Halysites catenulatus*, the characteristic and most abundant fossil of the Niagara limestone in this region. This coral was in the form of a cast, while those of the Niagara are uniformly silicified, this, with other circumstances, removing all possibility of error in regard to its true locality. A single specimen of the same genus is described by Mr. Hall as occurring in the Hudson river group on Green Bay, these two being the only instances in which this genus has been found in the United States in Lower Silurian rocks.

The Galena limestone forms a very important member of the series in the Upper Mississippi valley and in Wisconsin, although not distinctly recognized to the eastward of the Menomonee river; it is fully 250 feet thick in the vicinity of Dubuque, where it has its maximum development, and from which point it gradually thins out in every direction. It is, economically, of high interest, from the fact of its being the chief repository of the lead ore which has been, and still is, so extensively mined in the Upper Mississippi lead-region.

Hudson River Group.—This member of the series according to the Report is first distinctly recognized in its extension west of Little Bay des Noquets. Being composed chiefly of silicious and silico-argillaceous shales, which disintegrate with rapidity, so that a good natural section is rarely exposed, its existence in the Upper Mississippi valley was for a long time overlooked, although many of the shafts in the lead region are sunk through a greater or less thickness of it, in order to reach the underlying limestone. It did not escape the observing eye of Percival, who mentions it in his first annual Report, dated 1855, under the name of "Blue Shale," but without any indicatión of its palæontological relation or thickness, as, indeed, it has, within the limits of the lead-region in Wisconsin, been almost entirely removed by denundation. The thickness of these shales, when fully developed is from 60 to 80 feet, and in some places perhaps, as much as

100, but no natural section has been observed exposing more than 25. The quantity of organic remains crowded into some of the layers of this group, is truly astonishing; some strata of six or eight inches in thickness are made up of Orthocerata packed as closely together as they can lie. The palæontology of this formation has not been investigated in detail, but its position and the general character of its fossils leave no doubt of its equivalency with the Hudson river group.

An interesting fact in connection with these shales, is the large amount of bituminous matter which they contain, and which is shown in this Report to be characteristic of this group from New York, through Canada, to the Mississippi river. A specimen of a dark chocolate-colored shale from Savannah, Ill., was found to contain 20·96 per cent of combustible substances: other specimens from the vicinity of Dubuque, lost, on ignition, from 11 to 16 per cent. of organic matter. The black, highly-glazed and apparently very carbonaceous shales of the Hudson river valley, which have been so frequently mistaken for coal, contain from one-half to one per cent of carbon, but no volatile matter; while specimens of the Utica shale from Herkimer Co., on the other hand, lost from 12 to 14 per cent of their weight when burned in oxygen.

The presence of carbon in the shales of the Hudson river group over so extensive a region, and in so large quantity, is not only a matter of very considerable economical importance, as indicating a source from which, in those parts of the country where the true Carboniferous rocks are wanting, a supply of material for lighting, and perhaps heating, purposes may be obtained; but it is also of great interest in a theoretical point of view, as bearing on the question of the origin of the carbon in the coal-measures themselves. These shales and slates seem to have been accumulated under conditions somewhat resembling those which prevailed during the deposition of the Carboniferous series, while the presence of so large a per-centage of carbon in them is rendered still more striking by the fact, that, in the Northwest, neither the rocks below, nor those above as far up as the coal-measures, contain more than the merest trace of carbonaceous matter. From the base of the Potsdam to the top of the Galena limestone, the whole amount of carbon present in the rocks, would not, if collected into one layer, make a deposit of more than an inch or two in thickness; but if the bituminous matter of the Hudson river shales at Savannah, were all collected by itself in one stratum, instead of being diffused through perhaps 60 or 80 feet of shale, that stratum would have perhaps equalled twenty feet or more in thickness. A further investigation into the exact nature and distribution of the bituminous matter is contemplated.

Niagara Limestone.—This is the third great mass of dolomite, which, throughout the valley of the Upper Mississippi, lies next above the Hudson river shales, and which, as well from the extent of surface covered by it as from its thickness and persistency of lithological and palæontological characters, forms one of the most important members of the Silurian series in the Northwest. It is one of the rocks which, prior to the recognition of the Hudson river shales in the Northwestern mineral region, was included under the designation of "Cliff limestone;" and, more recently, has been described as the "Coralline and Pentamerus beds of the Upper Magnesian limestone,"—the term "Upper Magnesian limestone," according to Dr. Owen, including all the members of the series from the base of the Galena, up to the base of the Hamilton group. The Niagara limestone of the region in question is a nearly pure dolomite having a crystalline structure and a light yellowish gray color; it differs but little in external appearance from the Galena limestone, and hand-specimens of the two rocks might frequently be mistaken for each other. The Niagara limestone, however, does not often exhibit that tendency to irregular decomposition, and consequent weathering in fantastic forms, so characteristic of the Galena; it also contains a greater amount of silica in the form of layers and nodules of flint, and it differs from this last mentioned rock also, in the fact that the fossils it contains are usually silicified, and not preserved in the form of casts simply. It may also be noticed that, whereas in the Lower Magnesian and Galena groups the amount of magnesia present is almost exactly that required to form with the lime and carbonic acid, the double carbonate, or dolomite; in the Niagara, on the other hand, there is frequently a small excess of lime over the magnesia. The thickness of this member of the series is estimated at about 350 feet, 250 feet being the greatest amount measured in any one exposure. The Niagara limestone throughout the Northwest is marked by the presence of beds crowded with the *Pentamerus oblongus*, as also by numerous corals, of which *Halysites*, *Favosites*, *Heliolites*, *Syringopora* and *Lyellia* are the most conspicuous genera. There are also numerous Crinoids identical with, or closely allied to, those of the Niagara limestone of New York, but mostly in a very bad state of preservation, as might be expected in a crystalline dolomite.

Le Claire Limestone.—Of the groups recognized, in New York, as intermediate between the Niagara and the base of the Devonian, but a meagre representation has been observed in Iowa, and that only on the Mississippi river. The Le Claire limestone is described by Mr. Hall as a very heavy bed of dolomite, several hundred feet in thickness, which, in consequence of its disturbed condition and enduring character, has been the cause of the

Upper Rapids of the Mississippi. The fossils in it are all in the form of casts, and among them are, a small *Spirifer*, a *Spirigera*, a *Pentamerus*, undistinguishable from *P. occidentalis*, several Gasteropods and some chambered shells. This dolomitic mass is placed, conjecturally, on a parallel with the Galt limestone of Upper Canada, hitherto supposed to form the base of the Onondaga Salt Group. The Le Claire limestone has not been traced to any distance from the river, and is certainly wanting in northeastern Iowa, where the Niagara limestone is overlaid directly by rocks of the Hamilton group. It appears that a further examination should be made of the section at the Upper Rapids, as it is difficult to understand how so thick a mass of rock should appear and disappear without having been recognized anywhere except at that one point.

The Onondaga Salt Group, a member of the Silurian series of so much economical importance in New York, is represented in the Mississippi river section by a few feet only of magnesian limestone, or nearly pure dolomite, although soft and destitute of crystalline structure. The peculiar physical condition of the Onondaga Salt Group, as it exists in New York, is exhibited in some of the layers of the section on Quarry creek, a small tributary of the Mississippi, but the economically valuable minerals are wanting. This group has not been traced west of the Mississippi, where, indeed, it exists only in a few detached fragments.

Of the rocks of Devonian age, the *Upper Helderberg Limestone*, so well marked in New York and Ohio, is with difficulty to be recognized to the west of the Mississippi. Certain non-fossiliferous strata cropping out on the bank of that river, at, and for two or three miles above, Davenport, are referred by Mr. Hall to that group, chiefly, as it appears, from their stratigraphical position and lithological character.

The Hamilton group is an important member of the series in Iowa, covering many hundred square miles of surface, although greatly diminished in thickness from what it was in New York. It consists of a series of purely calcareous and calcareo-magnesian strata, with occasional bands in which argillaceous matter occurs to some extent, the lithological character of this portion of the series being somewhat more variable than that of the groups below. The greatest thickness of this group exposed in any one section appears to be about one hundred feet; but its entire development has not been satisfactorily ascertained. A few of the species of fossils found in it are identical with those occuring in New York; but most of them are new. Several are more like Devonian species of Central Europe than any which had been previously described from this continent.

The Chemung group in the Mississippi valley gives but a meagre representation of the same series of rocks in New York, Pennsylvania and Ohio. It contains almost an entirely new Fauna, although of species closely allied to those of more easterly localities of the same group.

The passage from the Devonian to the *Carboniferous series* is shown, in this Report, to be an almost imperceptible one, both in the physical and palæontological character of the groups, there being no strong line of demarcation separating the upper calcareous beds of the Chemung group from the Burlington limestone, the lowest member of the Carboniferous limestone series.

One of the most interesting facts brought out in this connection, is the existence of five distinct members of the Carboniferous limestone series. These are shown to have been deposited in an ocean which was gradually contracting its limits on the north, the greatest development of each successive member of the series, in an ascending order, being to the south of the one below it; while, subsequent to the deposition of all these and the sandstone which separates the fourth and fifth limestones, the entire area was submerged, allowing the coal-measures to be deposited on the slightly inclined edges of all these limestones, as well as of the Chemung and Hamilton rocks, and also, to some extent of the Silurian limestone, after they had been disturbed and denuded.* All these limestones of the carboniferous series are well characterized by the fossils they contain.

The fossils of the survey are described and figured in Part II on Palæontology, by Prof. Hall, this portion of the volume extending to 250 pages. The Devonian and Carboniferous series have been selected for illustration, as the Silurian had previously received much attention in the Reports of Dr. Owen. In the Hamilton and Chemung groups the fossils are particularly interesting, as exhibiting the influence of geographical conditions, or of distance, while the physical condition remained nearly the same as in central and western New York. The entire number of species described from all these rocks is about 250.

Special attention is given in the Report to the fossils of the Carboniferous limestones, as illustrating the successive members of the series; and with this object contrasting forms have not been selected, but, on the contrary, the more common and characteristic fossils of each rock. Many hitherto believed to be identical with European species are proved to be quite distinct.

The number of species of Crinoids, described in the volume, is probably equal to or greater than all those before made known

* See this Journal, [2], xxiii, 187.

from the same formations. Those of the Carboniferous limestones amount to one hundred and seventeen species, and of these *eighty-nine* are new or not before described.

The true generic characters of *Zeacrinus*, *Agaricocrinus* and *Agassizocrinus* of Troost,—genera which that author had given in his catalogue, but of which he had never published the full descriptions—are here for the first time given. In this and other cases Mr. Hall has evidently aimed to recognise fully the unpublished labors of Prof. Troost. He has on page 544 the following note:—

"I have transcribed these observations, as well as the specific description of this species, from the MS. of Dr. TROOST'S memoir upon the Crinoideæ, which is to be published in the Smithsonian Contributions to Knowledge; having been permitted to make such references and citations as would enable me to verify any of the genera and species which I might describe in the Iowa Report. By this means, although Dr. TROOST'S paper has not yet been published, he has the precedence which belongs to him."

The *Scaphiocrinus* in its typical species so nearly resembles the *Graphiocrinus* of De Koninck and Le Hon that Mr. Hall is led to suspect that they have overlooked a series of small basal plates. These characters are here illustrated; and in the *Forbesiocrinus* is shown a series of three basal plates below the five plates supposed by these authors to constitute the base. This genus is further sustained by five American species, all of which are new.

Some interesting facts are shown, for the first time, connected with the structure of the *Actinocrinus*, and particularly the distribution of the arms and their relations to the rays or radial series of the plates of the body. These relations, as well as other important points for the discrimination of species are shown in the diagrams accompanying many of the descriptions with a formula of numbers belonging respectively to the anterior, antero-lateral and postero-lateral rays. These characters, shown to be constant, offer important additional facilities for the determination of species, especially where specimens are imperfect.

Of the genus *Actinocrinus* alone twenty-nine new species and two varieties are described, and of the genus *Platycrinus* sixteen new species. *Rhodocrinus* is noticed for the first time among American Carboniferous species. Five species of the genus *Archæocidaris* are described and illustrated, one from each of the limestones of the Carboniferous series.

This Report is doubtless the best contribution yet made to our knowledge of the Crinoids and other Echinoderms of the Carboniferous system; and, both as regards their structure and their geological distribution, it is of the highest interest. We might cite at length important observations on the genera and species,

did space allow. The plates are all good, and those of Crinoids remarkably beautiful and effective.

In the chapter devoted to Economical Geology, we find a large number of analyses of the rocks, coals, and other materials of economical value occurring in Eastern Iowa. The limestones analyzed are many of them almost chemically pure dolomites; and, in general, the predominance of crystalline carbonates of lime and magnesia over the purely detrital rocks is very marked all through the series. There is a striking deficiency of the argillaceous element, especially, in all the Silurian rocks. The analyses, taken together, exhibit a tendency, as we rise in the geological scale, to a greater variety of lithological character in the members of the successive groups, a greater amount of detrital matter and a diminution in the quantity of magnesia, there being no heavy and persistent bed of dolomite above the Silurian.

Among all the specimens examined, the only ones found to contain a sufficient quantity of insoluble matter to be available for hydraulic lime are those from the Buff limestone, at the base of the Trenton. It remains to be ascertained, by practical trials, how far the dolomites and highly magnesian limestones, with but a small quantity of insoluble matter, can be used for hydraulic purposes, as they have been to a limited extent in Virginia and also in France.

The analyses of numerous samples of coal show that they belong, like all the Western coals, to the highly bituminous class; they contain from 35 to 40 per cent of bituminous matter, and from 45 to 50 of fixed carbon. They all appear to hold a large amount of hygrometric moisture with great tenacity, parting with it slowly, and not until after years of exposure to a dry atmosphere. Some samples give as much as fifteen per cent of water, expelled by drying at a temperature of 212° F. Sulphur is present in all these coals, in a form not perceptible to the eye, to the amount of from one-half of one to two per cent, and also in much larger quantity, in combination with iron and lime, as pyrites and gypsum, which substances materially impair the value of western coals. No workable iron-ore of any importance has been discovered in connection with the coal-measures of Iowa, which are exceedingly thin, no section having been measured in the Des Moines valley giving much over a hundred feet in thickness.

The subject of the occurrence of the lead ore in the Lower Silurian limestones of the Upper Mississippi valley, and, especially, within the limits of Iowa, is discussed in this Report on pages 422 to 468. The principal crevices, or lead-bearing fissures, which have been worked in the vicinity of Dubuque are described, and a diagram given illustrating their surface-

arrangement, so far as could be made out from the information collected. In no part of the lead region are the crevices developed on a more extensive scale, or with so much regularity, as in the Dubuque district. The characteristic form of occurrence of the ore is the *cave-opening*, or expansion of the vertical crevice into a cave or chamber, whose walls are sometimes lined with a heavy incrustation of pure galena, but which are more generally partially filled with clay and loose masses of rock, mixed with fragments of ore, derived from the decomposition of the material which once filled the *opening*, or metalliferous portion of the rock. Some of these caves have yielded several millions of pounds of galena, from a space very limited in depth and length.

It is a favorite idea among those who have little acquaintance with mining operations in general, or who wish to dispose of abandoned lead-mines to Eastern capitalists, that the lead crevices extend indefinitely downwards, and that the only reason why deep mining has not been carried on in this region is that the miners have not sufficient skill or capital to work down to any considerable depth. It has also been insisted on by the same class of persons, that the Lower Magnesian limestone is a good mineral-bearing rock, and that lead-mining may be carried on in it with profit, while the expediency of sinking shafts through the Upper Sandstone into this rock in search of ore, has often been discussed and urged by them. In regard to these points, of so much economical importance to the lead-region, the Report has the following:*

"There is very little evidence that the crevices continue to be productive, in the Dubuque district, even as low down as the Blue limestone; and it is certain from the study of the whole region, that they are everywhere completely cut off by the Upper sandstone. In no instance, so far as we have been able to learn, have the lodes been found to extend more than a short distance into the sandstone, or to be productive of galena in that rock. It is true that, in some localities, ore has been found in the limestone underlying this sandstone (the Lower Magnesian), when this rock occupies the surface; but the deposits in that geological position are very few in number, and the ore limited in quantity; we have yet to learn of a single instance in which diggings in that rock have been profitable for any length of time. But, again, even if the Lower Magnesian were a good mineral-bearing rock, there would be little encouragement to continue sinking from the Galena limestone, through the sandstone, into the underlying sandstone; for there is no reason to suppose that a crevice, after being entirely interrupted in the sandstone, would be resumed in the limestone below, at a point exactly in the line of direction of the workings above. A miner would be no more justified in

* Report p. 462.

sinking through the sandstone, in the expectation of meeting a continuation of his crevice in the Lower Magnesian, than he would be in commencing a shaft anywhere at random in this rock, without regard to surface-indication, and expecting to strike a valuable lode. He might possibly find one; but the chances would be more than ten-thousand to one that he would not."

That the amount of lead produced in the Upper Mississippi region is gradually diminishing is evident from the statistics; the maximum produce of these mines was in the years 1845–47, when it was nearly 25,000 tons per annum. At present it amounts to less than half that. In answer to the question, what can be done to develop the mining interest of this region, a systematic topographical and mining survey of the whole lead-bearing region is urged as an indispensable preliminary to future successful explorations. A more or less symmetrical disposition of the crevices will be found to prevail, and from the symmetry of the known, the position of the unknown may possibly be ascertained. There is no doubt that heavy bodies of ore yet remain concealed under the thick covering of drift, which makes surface explorations so expensive, and that a large amount of labor is wasted in fruitless search for workable lodes which might be more profitably expended if more systematically directed.

The existence of zinc ore in sufficient quantity and under suitable conditions with reference to fuel, labor, and a market, is pronounced highly questionable. Gold is not to be looked for, except in the most minute quantity, a caution inserted with special reference to the gold-fever raging in Central Iowa, at the time this portion of the Report was passing through the press. Specimens of considerable size may, possibly, have found their way out of the pockets of returned California miners, into the soil of Iowa.

In closing the Report, we would express our earnest hope that the survey so well begun, may be continued to its completion, and that other volumes as valuable may soon follow.

ART. XVI.—*Correspondence of Prof. Jerome Nicklès, dated Paris, October 26th,* 1858.

Scientific Association at Carlsruhe.—We ask our readers this time to go beyond the bounds of France across the Rhine. We need make no apology for this, as science is of all countries, and the announcement of scientific news is our special duty as correspondent of the American Journal.

The German Scientific Associations are generally highly interesting, as much for the men that attend them as the subjects discussed. Few meetings however have been as important as this 34th, held at Carlsruhe,

the capital of the Grand Duchy of Baden. It was remarkable for the sympathy between the government and the people, and also for the men there gathered and the papers brought forward. The first of the chemists and physicists of Germany were there; and geology, mineralogy, botany, zoology, and medicine had equally distinguished representatives. As the meeting was divided into sections, we could not hear all, and selected those departments according with our own predilections,—physics and chemistry; and we therefore confine our communications to facts brought out in these two sections.

The presidents of the section of chemistry were successively Liebig, Wöhler, Schönbein, and on the declinature of Bunsen, H. Rose. The sessions began on the 17th of September.

Schlossberger on the property of ammoniacal oxyd of copper dissolving cellulose.—This property was made known some years since by Schweitzer. Not only cellulose but also silk is soluble in this reagent. The ammoniacal sulphate of copper acts as a solvent only from the excess of oxyd of copper present. Mr. Schlossberger finds that the solvent power increases with the proportion of copper, and that the hydrate of copper dissolved in ammonia acts better than the sulphate.

The cupro-ammoniacal liquid does not dissolve gum, dextrine, starch, while it does dissolve filtering paper. The salts, and especially the alkaline salts, precipitate this solution of cellulose, and sulphate of copper has the same effect. The precipitate shows no trace of organization or crystallization; and it does not appear to differ in percentage composition from that of cellulose.

These same alkaline salts do not precipitate the solution of silk, and the fact may be made the basis of a process for separating silk from cotton. The solution of cellulose is precipitated also by alcohol, a concentrated solution of honey, gum Arabic, or dextrine. The cupro-ammoniacal liquid has no action on pyroxyline or collodion. Inuline, chitine, conchyoline, are insoluble in it.

Mr. Schlossberger has found that the ammoniacal hydrate of nickel, $NiO H^3N$, acts like the salt of copper. The solution of silk is however a fine blue in the latter and a yellowish brown in the former.

J. Nicklès on the diffusion of fluorine and the means of detecting it.—In this paper, the subject of which has been briefly presented in this Journal before, the following conclusions were arrived at.

1. There is fluorine in the blood, but less than has been supposed.

2. There are only small traces of fluorine in bones. After Berzelius, the proportion is 3 grams in 100 grams of the calcareous part of bones; but we have shown that there is hardly 0·05 in a kilogram.

3. The sources from which the animal organization may derive fluorine are: (*a*) potable waters; (*b*) vegetable substances,—although some contain so little that it is necessary to experiment on a kilogram at least of ashes, and on the products of evapoiation of some thousand litres of water. Besides, some mineral waters are a source containing fluorine in even a large proportion—a fact that may explain the efficiency of certain mineral waters that are feebly mineralized, such as those of Plombières, and Mont d'Or, etc.

4. The water of the Seine taken at Paris, is one of those containing the least fluorine.

5. Of the rivers of France, one of the richest in fluorine is that of the La Somme near Amiens.

6. Mineral waters vary in amount of fluorine; the richest examined are, the waters of Contrexeville, Antogast, Rippoldsau, Geilnau and Châtenois (Bas-Rhin). Reactions may be obtained from a litre of these waters.

7. The Atlantic affords no sensible amount even from 300 litres, showing thus a striking difference between marine and mineral waters.

8. The law of the diffusion of fluorine may be thus expressed: *There is fluorid of calcium in all waters containing bicarbonate of lime, and therefore there may be fluorine in all rocks and minerals formed in a sedimentary way.*

9. There are two sources of error in the usual method of detecting fluorine—one arising from the fact that sulphuric acid alone will attack glass, and the other from the fact that this acid often contains small quantities of fluohydric acid.

10. These sources of error are eliminated from my methods—by using (*a*) quartz crystals in place of glass, and (*b*) sulphuric acid free from fluohydric acid.

11. The solvent which I use is chlorhydric acid, which, with a little care, may be found free from fluorine in the shops.

In the memoir I point out the circumstances under which such a chlorhydric acid may be produced in the manufacture in the large way.

On the Preparation of Ozone by von Babo, and by Messrs. Bunsen and Magnus.—The apparatus in which ozone is obtained by the combustion of phosphorus, permits of separating the gas from the phosphorous acid with which it is ordinarily mixed. This result is attained by causing the gas to pass through a solution of chromic acid. This acid not only oxydizes the phosphorous acid, but, as Baumert has shown, it increases the quantity of ozone; for after the washing there is more ozone than before, evidently because the oxydation of phosphorous acid is itself a cause of ozonization.

Von Babo has succeeded in drying ozone so far as to render it anhydrous, whence it follows that ozone, or at least this kind of ozone, cannot be confounded with the hydrogenated ozone HO^3 discovered by Baumert.

Bunsen and Magnus, who made remarks on this paper, expressed the opinion that we must admit two kinds of ozone, one allotropic oxygen and the other a hydrogenated compound.

Schönbein on Ozone.—See page 19 of this volume.

Notices by Prof. Erdmann, of Leipzig.—The name of Erdmann is in high regard among chemists, as well from his fine researches, as from his being the early teacher of the lamented Gerhardt.* Erdmann had the insight to detect the future greatness of this distinguished chemist and to open the treasures of his science to his pupil—so early deceased—whose labors have so greatly enlarged the horizon of chemistry.

It was our good fortune to make the personal acquaintance of the first master of our lamented friend, and to obtain from him information on the

* See our biog. notice of Gerhardt, this Jour., Jan., 1857, p. 102.

obscure points of his youth and his early scientific career. From this source we derive our knowledge of several new facts first established in his laboratory.

(1.) *Blistering principle of Ranunculus sceleratus.*—This principle occurs under the form of an acrid oil, which on the tongue is changed into a white mass of *anemonine* and *anemonic acid.* This transformation occurs in the plant during desiccation, but the vegetable then loses all its bitterness.

(2.) *Action of certain Metallic Salts on ligneous fibres.*—It is well known that to preserve wood, and particularly the ties of railways, it is usual to impregnate them with a solution of sulphate of copper. This salt combines with the fibre in a manner so intimate as to preserve it from the action of water, which has no effect to dissolve out the copper salt even when the prepared wood is submerged. This change happens only to wood in its natural state, for if the fibre is purified from albuminous matters, &c., although the copper salt appears to combine perfectly with it, on the least action of water. it is dissolved out. Dilute solutions of sulphate of copper, in fact, remove the azotized substances from wood.

(3.) *Solubility of Sulphate of Baryta.*—This salt, one of the most insoluble of all substances in water, is soluble in water containing nitrate of ammonia, a concentrated solution dissolving sulphate of baryta in considerable proportion.

On new hydrocarbons and a new property of these bodies; by Mr. Fritzsche, of St. Petersburgh.—These hydrocarbons have been discovered in the tar resulting from the distillation of wood. They possess the peculiarity of forming beautiful and well defined crystalline compounds with picric acid, as well as those known of naphthaline and benzine. As the researches of Fritzsche have been some time published, we refer the reader to his memoir.

Manufacture of Soda and Baryta; by Mr. Kuhlmann.—The new facts established by Mr. Kuhlmann, of Lille, owe their discovery to a desire to render salubrious the manufacture of carbonate of soda by the process of Leblanc, which has heretofore been predjudicial to the public health, owing to the vast volumes of chlorhydric acid gas which have pervaded the atmosphere near such establishments. Mr. Kuhlmann has succeeded in avoiding this nuisance by the following process: He conducts the acid gases over masses of native carbonate of baryta, which arrest the hydrochloric acid, forming chlorid of barium. This salt, by means of dilute sulphuric acid, is changed into sulphate of baryta, which is now in great demand in the arts under the name of *blanc fixe* (permanent white). He manufactures 2000 kilograms per day.

Another new fact established by Mr. Kuhlmann relates to the economy of the residues of chlorid of manganese, resulting from the production of chlorine and hypochlorites. These residues retain a large quantity of chlorine, and Mr. Kuhlmann, who is one of the principal manufacturers, estimates the loss from this source to be not less than two million francs in France alone.

This skilful chemist has contrived two uses for these residues. Either he transforms them into chlorid of barium by means of carbon and sul-

phate of baryta, or he treats them by another residue which encumbers the soda-industry, viz., the oxysulphid of calcium, by which sulphid of manganese and chlorid of calcium result. The latter salt is now beginning to be used to prevent combustion and to water streets in summer, where by its hygroscopic properties it keeps down the dust.

All these researches were brought up in the first two sessions of the chemical section; but the third session was united with that of the physical section. On the next day there was an excursion to Baden Baden, when the Congress was fêted by that city. The Monday session was commenced at 11 o'clock, and there were many interesting experiments exhibited. The chief were—

Dove's Experiment in Acoustics.—This experiment consists in rendering the tone from a vibrating diapason, very distinct, so that it could be heard through the whole hall, by causing it to vibrate in a certain relation to a glass flask containing water. The flask should not be filled and the diapason should not touch it, but be held by the hand in the prolonged neck of the balloon. The sound returned depends on the position of the two limbs of steel to the neck of the flask. The perception of sound is most distinct when the plane of the two branches is in the axis of the neck, and it is null when this plane is perpendicular to the axis.

Dove ascertained these facts while engaged in researches as to the question whether the ear, which is for a time sensible to a certain tone, becomes insensible to it again, as the eye does to a given color when it has for some time contemplated it. The eye may be said to habituate itself to certain colors, as the olfactory nerves do to persistent odors. Dove's researches returned an affirmative reply to the point in question.

Magnus on the properties of iron in powder.—Metallic iron in a state of very fine division has for some years been used in medical practice. It is thus obtained when the oxyd of iron is reduced by hydrogen. When well prepared this form of iron is so combustible as to take fire on exposure to air, burning with scintillation. A manufactory has lately been established in the Tyrol for making iron-powder, of very considerable fineness—although the process is mechanical, consisting in using very fine files. Its therapeutic properties have not yet been decided. It does not burn spontaneously in air although it is extremely combustible, as the following experiment by Magnus demonstrated to the section. When a burning body is approached to these Tyrolean filings they do not inflame unless they are previously suspended from the poles of a magnet. It is an experiment easily repeated and interesting in a lecture. If a magnet be thus armed with these fine filings, and a flame applied, a combustion begins which spreads rapidly, and if the magnet is jarred a shower of burning particles fall through the air.

Boettger—Action of cold and warm water on horny substances.—This skillful experimenter whose tact in manipulation is well known, having obtained the floor of the Section, took a goose feather, placed it between the thumb and fore-finger of one hand and with the other crushed it into a crumpled mass. He then by a little manipulation restored it completely to its primitive state. The treatment by which this was accomplished was simple enough. After being left for some minutes in warm

water it was plunged into cold water; this restored the rigidity of the feather previously swollen by the warm water.

Schroeder—Relation between fermentation and crystallization.—In 1854 Mr. Schroeder in connexion with Mr. Dusch published a paper on fermentation and putrefaction, and showed that putrescent and fermentable substances could be indefinitely preserved, if instead of leaving such matter in common air, they were placed in vases filled with air that had been filtered through cotton. Flesh, soup, and all kinds of alimentary substances can thus be preserved, if the precaution has been taken previously to boil them in water.

Mr. Schroeder shows that what he has established concerning fermentation and putrefaction, is also true of crystallization. It is well known that a saturated solution of sulphate of soda remains liquid as long as it is in vacuo, but solidifies on access of air. Mr. Schroeder establishes the fact that crystallization does not take place if the air is made to pass through a tube filled with cotton.*

Mr. S. explained the results of his experiments in 1854 by supposing that the air filtered through cotton is deprived of the spores of cryptogamic infusoria, which are the cause of putresence and fermentation. If the experiment on the sulphate of soda tends to establish a relation between fermentation and crystallization, it serves to prove also that these phenomena can take place without the presence af these cryptogamia or infusorial germs, suspended in unfiltered air. This question which appeared to us finished by the earlier researches of Mr. Schroeder, comes up anew. These facts do not interfere with the mechanical theory of Liebig, nor that derived from the recent researches of Pasteur on the propagation of fermentation.

J. Nickles—Electromagnets and Magnetic adhesion.—The experiments on this subject have been reported briefly in former communications. They have acquired a new interest since the French Government has ordered General Morin, of the Department of Arts and Trades, to take up that part of my researches which is applicable to locomotion on railroads.

Before my investigations, only two kinds of magnets were known, the *straight* and the *horseshoe* or *bifurcate.*† In 1852 I made known the *trifurcate* magnet, (or magnet with three poles having only a single helix for magnetization although possessing considerable attracting power,) and the *paracircular* magnets,‡ and afterwards the *circular.* § These last two kinds have some special properties, and are capable of transmitting motion as the revolution takes place, but the magnets which I call *circular* are polished at the circumference and without teeth. These magnets attracted much attention on account of their peculiarities and practical applications. One of them has been put in action on a large scale on the Lyons railroad.

This meeting of the German Association was without representatives from England, and but for the position of Carlsruhe would scarcely have had any from France. This is owing principally to the fact that Associations are in session in England, France, Italy and Germany at nearly the same

* Journal de Pharmacie and de Chemie, 1854, T. xxv, p. 314.

† This Journ., xv, 104, 380. ‡ Ibid, xvi, 110. § Ibid, xx, 99.

period of the year. The only way to remedy this difficulty is to substitute for these partial associations, a *European Scientific Association*, precursor to a *Universal Scientific Association*, which shall hold its sessions in turns at the different cities of the old and new continent.

Bibliography.—At H. Bossange's: *Researches on the Diffusion of Fluorine*, by J. Nicklès. 60 pp. 8vo.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On the Siliciuret of Hydrogen.*—Wöhler has communicated a purely chemical method of preparing the siliciuret of hydrogen discovered by Buff and himself as a product of the electrolysis of an alloy of silicon and aluminum. The method in question was accidentally discovered in Wöhler's laboratory by Martins, who found that a scoria or slag arising from the preparation of magnesium by Deville's process, disengaged a spontaneously inflammable gas when treated with chlorhydric acid. The magnesium compound required in the preparation of the gas is prepared in the following manner: 40 grams of fused chlorid of magnesium, 35 grams of strongly dried fluosilicate of sodium, and 10 grams of fused chlorid of sodium are to be finely pulverized and intimately mixed in a hot mortar. The mixture is to be introduced into a glass vessel which can be closed, and 20 grams of sodium in very small pieces added. The whole is to be mixed by agitation, and then forced at once into a Hessian crucible, heated to redness. The crucible is to be covered and heated, when the combination takes place with repeated decrepitations. When these have ceased and flames of sodium no longer appear, the crucible is removed from the fire, allowed to cool, and broken. It contains a greyish-black fused mass filled with globules and plates resembling cast iron. The coarser pulverized mass is to be introduced into a flask with two tubulures, through one of which passes a funnel with a tube long enough to pass to the bottom of the flask, to the other tubulure is attached a short and wide conducting tube. The entire apparatus is now to be filled with boiled water, and then plunged beneath the surface of the pneumatic cistern, so that every bubble of air is expelled. A collecting tube may now be filled with water and inverted over the orifice of the tube conveying the gas. Strong chlorhydric acid is now to be poured through the funnel. A violent reaction ensues and much foam unavoidably passes over into the collecting tube with the gas; a second tube may, however, be filled with the gas without foam. The properties of the gas are as follows. Each bubble inflames on contact with air with a white flame and a violent explosion. The silicic acid formed produces beautiful rings like phosphuretted hydrogen. The gas is completely decomposed by a feeble red heat, brown amorphous silicon being deposited. When burned against a plate of porcelain it gives a brown spot. With chlorine the gas explodes violently, but not with protoxyd or deutoxyd of nitrogen. As thus prepared the gas still contains free hydrogen, which makes it difficult to determine its constitution. Siliciuret of hydrogen precipitates various metals from their solutions. A salt of copper agitated with the gas yields a red pellicle of a siliciuret of copper, which in the air oxyd-

izes to a lemon-yellow silicate of copper. Nitrate of silver yields with the gas a black substance which is doubtless a siliciuret of silver, mixed however with metallic silver: palladium is reduced by the gas to the metallic state. The greyish mass which yields the gas by the action of chlorhydric acid, appeared to consist of free silicon mixed with a siliciuret of magnesium which gives siliciuret of hydrogen by the action of chlorhydric acid, and of another siliciuret of magnesium which yields with chlorhydric acid free hydrogen and protoxyd of silicon. In one case the authors succeeded in isolating a lead-grey aggregate of regular octahedrons, sometimes presenting cubic surfaces. These were found to have the formula Mg_2Si, and as this compound yielded the spontaneously inflammable gas with chlorhydric acid, it is possible that the formula of this latter may be SiH_2. Martins is engaged in studying the subject further.—*Ann. de Chemie et de Physique*, liv, 218, Oct. 1858.

[NOTE.—It must be remembered that Wöhler and Martins take the equivalent of silicon as 21, so that silica is SiO_2. The siliciuret of magnesium above mentioned has no probable formula if we take silicon as 14, as appears necessary, since Marignac has shown the isomorphism of the fluosilicates and fluostannates. It is very much to be desired that those chemists whose means enable them to make such researches, should investigate the compounds of silicon with ethyl, methyl, &c. It can hardly be doubted that ethyl-zinc would give with chlorid or fluorid of silicon, a compound of ethyl and silicon having the formula $Si(C_4H_5)_2$ since we should have a reaction expressible by the equation

$$2\,.\,Zn(C_4H_5) + Si\,Cl_2 = 2Zn\,Cl + Si(C_4H_5)_2.$$

A determination of the density of the vapor of ethyl-silicon would possess much theoretical interest. The results obtained by Hoffmann and Cahours in the formation of compounds of ethyl, &c., with phosphorus and arsenic render the existence of similar compounds of silicon and boron almost certain.—W. G.]

2. *On protoxyd of iron with caustic potash as a reducing agent.*—HEMPEL finds that protoxyd of iron in the presence of an excess of caustic potash reduces iodic acid, bichlorid of platinum, and protochlorid of mercury. Platinum yields a black powder which after washing with water containing chlorhydric acid and drying, readily converts alcohol into acetic acid. A solution of chlorid of mercury treated with sulphate of iron and caustic soda, and then with sulphuric acid yields subchlorid of mercury and the filtrate is free from mercury. Nitrate and sulphate of protoxyd of mercury behave in this manner when a sufficient quantity of chlorid of sodium has been previously added. The author recommends this process for the determination of mercury, the precipitated calomel being collected on a weighed filter, washed and dried. To determine mercury volumetrically, Hempel gives the following process, which yields very good results. The solution of the chlorid, nitrate or sulphate of mercury (in the two last cases chlorid of sodium must be added,) is to be introduced into a capacious flask with a ground stopple, an excess of protosulphate of iron and caustic alkali added, the flask well shaken and the oxyd of iron dissolved by adding dilute sulphuric acid. The subchlorid of mercury is allowed to settle and the supernatant liquid filtered off. After complete washing the filter may be pierced and the contents washed down into the flask with the rest of the precipitate. A large excess of

dilute sulphuric acid and hypermanganate potash is then to be added, the flask closed and strongly shaken for two or three minutes. The undecomposed hypermanganate of potash is then to be removed by a solution of oxalic acid, and the excess of this last determined by means of a titred solution of the hypermanganate. The percentage of mercury is then easily calculated.—*Ann. der Chemie und Pharm.* cvii, 97.

3. *On the Iodid of Methylen.*—When powdered iodine is added to crystallized ethyloxyd-soda a strong reaction occurs, and the mass becomes fluid. By distilling the mass Buttlerow obtained a heavy oily substance dissolved in alcohol and precipitated from this by water: this is the iodid of methylen $C_2H_2I_2$. The same substance is formed in larger quantity when one eq. of iodoform C_2HI_3 is added to three eqs. of ethyloxyd-soda, and water added to the product of this reaction. The iodid is a heavy oily liquid of a yellowish color and of density 3·342: at 2° it solidifies to a crystalline mass. By heating the iodid with acetate of silver and a little crystallizable acetic acid to 100° extracting the mass with ether and then distilling, a colorless oily liquid passed over at about 170°. This is the acetate of methyl-glycol $\left.\begin{matrix} C_2H_2 \\ (C_4H_3O_2)_2 \end{matrix}\right\} O_4$. The author did not however succeed in obtaining methyl-glycol from this body.—*Ann. der Chemie und Pharmacie*, cvii, 110.

4. *On the action of Ammonia upon Glyoxal.*—By the action of nitric acid upon alcohol Debus obtained two new bodies termed respectively glyoxal $C_4H_2O_4$ and glyoxylic acid $C_4H_4O_8$. By the action of a warm and concentrated solution of ammonia upon glyoxal, Debus obtained a base having the formula $C_{12}H_6N_4$, its formation being represented by the equation

$$3(C_4H_2O_4) + 4NH_3 = C_{12}H_6N_4 + 12HO.$$

Glycosin the new base is a light white powder soft like talc and without taste or smell: it sublimes without melting, and yields beautiful needles. With bichlorid of platinum it yields a beautiful yellow crystalline powder, which has the formula $C_{12}H_6N_4 + 2(HCl, PtCl_2)$ or $C_{12}H_8N_4Cl_2, 2PtCl_2$. The rational formula of glycosin according to Debus is

$$N_4 \left\{ \begin{matrix} C_4H_2 \\ C_4H_2 \\ C_4H_2 \end{matrix} \right\}.$$

The mother-liquor from which the glycosin is obtained yields with oxalic acid the oxalate of a new base which the author terms glyoxalin, and which has the formula $C_6H_4N_2$. Glyoxalin is colorless and crystalline; its platinum salt has the formula $C_6H_4N_2, HCl + PtCl_2$ and crystallizes in magnificent orange-red prisms. The formation of glyoxalin is expressed by the equation

$$2(C_4H_2O_4) + 2NH_3 = C_6H_2N_2 + C_2H_2O_4 + 4HO.$$

Ann. der Chemie und Pharmacie, cvii, 199.

5. *On the constitution of Tantalite.*—H. Rose has published an elaborate discussion of the analyses of tantalite from different localities, and arrives at the conclusion that the formula of the unaltered mineral is $FeO, 2TaO_2$, a portion of the tantalic acid being replaced by stannic acid SnO_2 and zirconia, which latter has probably the formula ZrO_2, as Deville and Troost have suggested.—*Pogg. Ann.*, civ, 85.

6. *On Niobium.*—H. Rose has published in part, the results of his long continued and elaborate investigations of niobium and its compounds—investigations which may justly be considered as among the most difficult and tedious which chemists have ever undertaken. We shall content ourselves with a brief abstract of the most important points in the history of the metal.

Metallic niobium is most easily prepared by heating the double fluorids or hypofluorids of niobium and the alkaline metals with sodium to a strong red heat in a crucible of cast iron. After cooling, the black mass is to be diffused in cold water in a platinum capsule; the metallic niobium boiled with water, and finally washed with water containing a little alcohol, till the washings leave no residue on evaporation. The metal obtained is purer, when a tolerably thick layer of chlorid of potassium is placed upon the mixture of fluorids with sodium before ignition. Metallic niobium is a black powder which conducts electricity, and is acted on by reagents more easily than tantalum. Freshly prepared and still moist niobium when heated with dilute chlorhydric acid is dissolved with evolution of hydrogen. The colorless solution gave with ammonia a voluminous precipitate of a brownish color, which however oxydized upon the filter and became white. It is therefore clear that there exists a stage of oxydation of niobium which is lower than hyponiobic acid. Nitric acid does not dissolve niobium even on heating. Concentrated sulphuric acid dissolves metallic niobium by long heating, the solution has a brownish color and gives a brownish precipitate with ammonia. Fluohydric acid also dissolves niobium, and the solution is effected still more easily by a mixture of sulphuric and fluohydric acids. Fusion with carbonate of potash and boiling with caustic potash, also dissolve the metal. When heated in chlorine the metal ignites, both the yellow and the white chlorid being formed—the latter, Nb_2Cl_3, in large excess. This latter cannot be converted into the yellow chlorid $NbCl_2$ by heating in chlorine. The oxydation of niobium yields only hyponiobic acid Nb_2O_3, and not niobic acid NbO_2, so that in this respect the metal differs from tantalum. The density of the metal obtained from the fluorids was 6·297; of that obtained from the yellow chlorid by means of sodium, 6·272, but the density varied greatly in different specimens in consequence of the presence of more or less hyponiobic acid as impurity. When phosphorus vapor is passed over bi-hyponiobate of soda, heated to redness in a current of hydrogen, the metal is reduced and contains only a trace of phosphorus: this reduction takes place much less easily and completely in the case of tantalum. In his second memoir Rose treats of the chlorids of niobium. The yellow chlorid, $NbCl_2$, resembles the corresponding chlorid of tantalum, $TaCl_2$, but has a clearer and somewhat deeper color; it is also more volatile than the latter, beginning to pass over at 125° C., while chlorid of tantalum becomes gaseous at about 144° C. The chlorid of niobium melts at 212° C., and solidifies sooner than the chlorid of tantalum, which fuses at a rather higher temperature. Rose made repeated analyses of the chlorid of niobium, decomposing it with water, and determining the chlorine and niobic acid produced. These analyses from the extreme difficulty of the subject did not yield results which correspond as accurately as could be desired. The author rejects the results of the first five, and

from the mean of the last three deduces the numbers 48·82 (or 610·37 O = 100) as the equivalent of niobium.

Chlorid of niobium, $NbCl_2$, dissolves in chlorhydric acid; after some time the solution becomes turbid and gelatinizes. Water does not completely dissolve the mass, the filtrate is opalescent, and contains much niobic acid, which may however be almost completely separated by boiling. When, however, the chlorid is boiled with chlorhydric acid, a turbid solution is produced, which does not gelatinize, and forms with water a clear solution which is not precipitated by boiling. The chlorid dissolves in alcohol to form a clear solution, while a small quantity remains which gelatinizes with water. When the alcoholic solution is distilled, alcohol, chlorid of ethyl, and finally, chlorhydric acid pass over, while a syrupy liquid remains which dissolves in water, giving a clear solution from which nothing is precipitated by boiling. The syrupy liquid is doubtless niobate of ethyl. When chlorid of niobium is dissolved in chlorhydric acid, water added, and then metallic zinc placed in the solution, a beautiful blue color is produced. Bromine forms two compounds with niobium, one of which is yellowish and voluminous, and corresponds to the hypochlorid, while the other is purple-red, but becomes yellow on strong heating and volatilizes. The yellow color of the hypobromid and the red of the bromid appear to be due simply to the presence of free bromine.

In a third memoir the author treats of the fluorids of niobium. The hydrate of niobic acid dissolves readily in fluohydric acid, and the solution gives a series of crystallized double fluorids. The potassium salts are colorless and crystalline. Of these, one has the formula $KF + NbF_2$, while the other is $(KF + NbF_2) + (KF + HF)$. The soda salts are $NaF + NbF_2$, $(2NaF + NbF_2) + (NaF + HF)$, and $(NaF + NbF_2) + (NaF + HF)$. It is difficult however to obtain these salts in a state of purity.—*Pogg. Ann.*, civ, 310, 432, 581.

7. *On the constitution of titaniferous iron ores.*—Rammelsberg has published an elaborate investigation of the titaniferous iron ores, the principal results of which are as follows:

(1.) The greater number of the titaniferous iron ores, among them all the crystallized forms, consist of 1 eq. of titanic acid and 1 eq. of protoxyd of iron (prot. of manganese or magnesia).

(2.) Magnesia is an essential constituent of all these ores. In the crystallized mineral from Layton, the magnesia amounts to 14 per cent.

(3.) According to Mosander's theory the titaniferous iron ores are either simply titanates of protoxyd of iron $\dot{Fe}Ti$; with isomorphous admixtures of titanate of magnesia or mixtures of such with sesquioxyd of iron, for the most part in simple proportions.

(4.) The theory of H. Rose that these ores consist of isomorphous sesquioxyds of titanium and iron, would require the assumption of a sesquioxyd of magnesium.

(5.) The author prefers Mosander's theory for the present state of our knowledge.

(6.) In Iserin we find grains consisting of $\dot{Fe}Ti$, and $\bar{Fe}Ti_3$.

(7.) No titaniferous iron crystallizing in regular octahedrons is known. The dense masses or octahedral grains which contain titanium appear to be mixtures.

(8.) The crystallized magnetic iron ores contain no titanium, they consist of one atom of protoxyd and one atom of sesquioxyd.

(9.) All the Elba iron ore does not contain titanium, but all, like that from Vesuvius, contains magnesia and protoxyd of iron.

(10.) The strongly magnetic octahedrons from Vesuvius, hitherto considered as a specular iron, which are accompanied by rhombohedrons of specular iron, contain in part large quantities of magnesia, and in part protoxyd of iron. They consist either of magnetic iron which has been partially converted into sesquioxyd of iron, as well as of the isomorphous combination $\dot{M}g\ddot{F}e$, or, as is more probable, the two protoxyds are isomorphous with sesquioxyd of iron, which is itself dimorphous.—*Pogg. Ann.*, civ, 497.

8. *On a new acid obtained by the oxydation of malic acid.*—By the action of bichromate of potash upon a dilute solution of malic acid, Dessaignes has obtained an acid which has the formula $C_6H_4O_8$, and which may possibly be identical with the nicotic acid of Barral. The author terms it provisionally malonic acid, and remarks that it is probably homologous with oxalic acid, being the term hitherto wanting between oxalic and succinic acids. Malonic acid forms large rhombohedral crystals, and is easily soluble in water and alcohol. It has a strongly acid taste, melts at 140°, and is decomposed at 150°. By dry distillation it yields a mixture of acetic acid with unchanged malonic acid; carbonic acid is set free at the same time, the equation being

$$C_6H_4O_8 = C_4H_4O_4 + C_2O_4.$$

Malonic acid forms neutral and acid salts with the alkalies. Malonate of ammonia precipitates the salts of lime, baryta, silver and mercury. The author remarks that while the analogy between malonic and oxalic acids is strongly marked, the resemblance between malonic and succinic acids is much less distinct.—*Comptes Rendus*, xlvii, 76. W. G.

9. *Remarks on Chemical Science;* by Sir JOHN HERSCHEL, at the recent meeting of the British Association at Leeds.—Since organic chemistry has assumed, by the experiments and reasonings of Dumas, Liebig, Hoffmann, and its other distinguished cultivators, that highly abstract and intellectual form under which it now presents itself, and which by the links of the platinum bases, and compounds such as those described by Gibbs and Genth, under the name of the ammonio-cobaltic bases, and by those which are every day coming into view by the mutual interweaving if I may use such an expression, of the organic and inorganic systems of composition in bases such as those of the metallic ethyls and those of boron and silicon, it seems to place these conceptions in much the same sort of relation to the ordinary atomic theory as put forth by Dalton and Higgins, and the elementary notions of oxyd, acid, and base of Lavoisier, that the transcendental analysis holds to common algebra. And here perhaps I may be tolerated if I put in a word of reclamation against the system of notation into which chemists who for the most part are not algebraists, have fallen, in expressing their atomic formulas. These formulas have been gradually taking on a character more and more repulsive to the algebraical eye. There is a principle which I think ought to be borne in mind in framing the conventional notations, as well as nomenclatures of every science, at every new step in its progress, viz: that as sciences do

not stand alone, but exist in mutual relation to each other—as it is for their common interest that there should exist among them a system of free communication on their frontier points—the language they use and the signs they employ should be framed in such a way as at least not to contradict each other. As the atomic formulas used by the chemist are not merely symbolic of the mode in which atoms are grouped, but are intended also to express numerical relations, indicative of the aggregate weights of the several atoms in each group and the several groups in each compound, it is distressing to the algebraist to find that he cannot interpret a chemical formula (I mean in its numerical application) according to the received rules of arithmetical computation. In a paper which I published a long time ago on the hyposulphites, I was particularly careful to use a mode of notation which, while perfectly clear in its chemical sense, and fully expressing the relation of the groupings I allude to, accommodated itself at the same time perfectly well to numerical computation, no symbol being in any case juxtaposed, or in any way intercombined with one another, so as to violate the strict algebraic meaning of the formula. This system seemed for a while likely to be generally adopted, but it has been more and more departed from, and I think with a manifest corresponding departure from intelligibility.

The time is perhaps not so very distant when from a knowledge of the family to which a chemical element belongs, and its order in that family, we may be able to predict with confidence the system of groups into which it is capable of entering, and the part it will play in the combination. A great step in this direction seems to me to have been lately made by Prof. Cooke of Harvard University, in the United States, (in a memoir which forms part of the 5th volume of the Memoirs of the American Academy of Arts and Sciences,) to extend and carry out the classification of chemical elements into families of the kind I allude to, in a system of grouping, in which the first idea, or rather the first germ of the idea, may be traced to a remark made by M. Dumas, in one of his reports to this Association, and which is founded on the principle of arranging them in a series, in each of which the atomic weight of the elements it comprises are found among the terms of the arithmetical progression, the common difference of which in the several series are 3, 4, 5, 6, 8, and 9 times the atomic weight of hydrogen respectively. So arranged they form six groups, which are fairly entitled to be considered natural families, each group having common properties in the highest degree characteristic; and what is more remarkable, the initial member in each group possessing in every case the characteristic property of the group in its most eminent degree, while the others exhibit that property in a less and less degree, according to their rank in the progression, or according to the increased numerical value of the atomic equivalent. Generally speaking, I am a little slow to give full credence to numerical generalizations of this sort, because we are apt to find their authors either taking some liberties with the numbers themselves, or demanding a wider margin of error in the application of their principles than the precision of the experimental data renders it possible to accord, so that the result is more or less wanting in that close appliance to nature which makes all the difference between a loose analogy and a physical law; but in this instance it certainly does

appear that the groups so arising not only do correspond remarkably well in their theoretical numbers with those which the best authorities assign to their elements, but that it really would be difficult to distinguish the elements themselves into more distinctly characteristic classes, by a consideration of their qualities alone, without reference to their atomic numbers. When we find, for instance, that the principle affords us such family groups as oxygen, fluorine, chlorine, bromine, and iodine, self-arranged in that very order; or again, nitrogen, phosphorus, arsenic, antimony, and bismuth; when we find that it packs together in one group all the more active and soluble electro-positive elements, hydrogen, lithium, sodium, and potassium, and in another the more inert and less soluble ones—calcium, strontium, barium, and lead—and that without outraging any other system of relations, it certainly does seem that we have here something much like a valid generalization: and I shall be very glad to learn in the course of any discussions which may arise on such matters as may be brought before us in the regular conduct of our business from those more competent to judge than myself, whether I have been forming an overweening estimate of the value and importance of such generalizations.

I will only add on this point, in reference to what fell from our excellent President in his address to the assembled Association last night, that this kind of speculation followed out would seem to me likely to terminate in a point very far from that which would regard all the members of each of these family groups as allotropes of one fundamental one, inasmuch as the common difference of the several progressions which their atomic weights go to make up, are neither equal to nor in all cases commensurate with the first terms of these progressions. For instance, in the chlorine group, the first term being 8, the common difference is 9. Something very different from allotropism is surely suggested by such a relation. It would rather seem to point to a dilution of energy of one primary element by the superaddition of dose after dose of some other modifying element, and this the more strikingly since we find oxygen standing at the head of very distinct groups having very striking correspondence in some respects, and very striking differences in others. But all these speculations take for granted a principle, with which I must confess I think chemists have allowed themselves to be far too easily satisfied, viz: that all the atomic numbers are multiples of that of hydrogen. Not until these numbers are determined with a precision approaching that of the elements of the planetary orbits, a precision which can leave no possible question of a tenth or a hundredth of a per cent, and in the presence of which such errors as are at present regarded as tolerable in the atomic numbers of even the best determined elements shall be considered utterly inadmissible, I think can this question be settled—and when such gigantic consequences—so entire a system of nature is to be based on a principle—nothing short of such evidence ought, I think, to be held conclusive, however seductive the theory may appear. I do not think such precision unattainable, and I think I perceive a way in which it might be attained, but one that would involve an expenditure of time, labor, and money, such as no private individual could bestow upon it. If the phenomena of chemistry are ever destined to be reduced under the

dominion of mathematical analysis, it will no doubt be by a very circuitous and intricate route, and in which at present we see no glimpse of light. We should therefore be all the more carefully on the watch in making the most of those classes of facts which seem to place us, not indeed within view of daylight, but at what seems an opening that may possibly lead to it.

Such are those in which the agency of light is concerned in modifying or subverting the ordinary affinities of material elements, those to which the name of actino-chemistry has been affixed. Hitherto the more attractive applications of photography have had too much the effect of distracting the attention from the purely chemical questions which it raises, but the more we consider them in the abstract, the more strongly they force themselves on our notice, and I look forward to their occupying a much larger space in the domain of chemical inquiry than is the case at present. That light consists in the undulations of an etherial medium, or at all events agrees better in the characters of its phenomena with such undulations, than with any other kind of motion which it has been possible to imagine, is a proposition on which I suppose the minds of physicists are pretty well made up. The recent researches of Professor Thomson and Mr. Joule moreover have gone a great way towards bringing into vogue, if not yet fully unto acceptation, the doctrine of a more or less analogous conception of heat. When we consider now the marked influence which the different calorific states of bodies have on their affinities—the change of crystalline form effected in some by a changing temperature—the allotropic states taken on by some on exposure to heat—or the heat given out by others on their restoration from the allotropic to the ordinary form (for, though I am aware that Mr. Gore considers his electro-deposited antimony to be a compound, I cannot help fancying that at all events the state in which the the antimony exists in it is an allotropic one); when, I say, we consider these facts in which heat is concerned, and compare them with the facts of photography, and with the ozonization of oxygen by the chemical rays or the electric spark, and with the striking attractions in the chemical habitudes of bodies pointed out by Draper, Hunt, and Becquerel; and when again we find these carried so far that, as in the experiments of Bunsen and Roscoe, we find the amount of chemical action numerically measuring the quantity of light absorbed, it seems hardly possible not to indulge a hope that the pursuit of these strange phenomena may by degrees conduct us to a mechanical theory of chemical action itself. Even should this hope remain unrealized, the field itself is too wide to remain unexplored; and, to say nothing of discovery, the use of photography merely as a chemical test may prove very valuable, as I have myself quite recently experienced, in the evidence it has afforded me of the presence in certain solutions of a peculiar metal having many of the characters of arsenic, but differing from it in others, and strikingly contrasted with it in its powerful photographic qualities, which are of singular intensity, surpassing iodine, and almost equalling bromine.

There is another class of phenomena which, though usually considered as belonging peculiarly to the domain of general physics, and so out of our department, seems to me to want some attention in a chem-

ical point of view. It is that of capillary attraction. The co-efficient of capillarity differs very remarkably in different liquids, and no doubt also in their contacts with different solids, a fact which can hardly be separated from the idea of some community of nature between the capillary force and those of elective attraction. I hardly dare to hint at the existence of some slight misgiving I have always felt as to the validity of the received statical theory of capillary action which carries with it the authority of such names as those of Laplace and Poisson. Any discussion of this point would be matter for another section of this Association, and if I here touch upon it, it is only to observe my impression of the requisiteness of a force so far allied to chemical affinity as to be capable of saturation, rests on other grounds besides that of the mere diversity of action above alluded to. But I must remember that you are not met here to listen to generalities of whatever nature, but that we have plenty of real and special business before us.

10. *An account of some experiments on Radiant Heat, involving an extension of Prévost's Theory of Exchanges;* by Mr. B. Stewart, (Proc. Brit. Assoc., Ath. 1614).—These experiments were performed with the aid of the thermomultiplier, the source of heat being for the most part bodies heated to 212°. Four groups of experiments were considered. Group the first contains those experiments in which the quantities of heat radiated from polished plates of different substances at a given temperature, are compared with the quantity radiated from a similar surface of lampblack at the same temperature. The result of this group of experiments is, that glass, alum and selenite, radiate about 98 per cent of what lampblack does—thick mica, 92—thin mica, 81—and rock salt only 15 per cent. The second group of experiments was designed to compare together the quantities of heat radiated at the same temperature from polished plates of the same substance, but of different thicknesses. The result of this group was, that while the difference between the radiating power of thick and thin glass is so small as not to be capable of being directly observed, there is a perceptible difference between the radiation from thick and thin mica, and a still more marked difference between the radiation from plates of rock salt of unequal thickness. The third group of experiments was made with the view of comparing the radiations from various polished plates with that from lampblack, as regards the quality of the heat,—its quality being tested by its capability of transmission through a screen of the same material as the radiating plate. From this group of experiments it appears that heat emitted by glass, mica, or rock salt is less transmissible through a screen of the same material as the heated plate than heat from lampblack,—this difference being very marked in the case of rock salt, which only transmits about one third of the rays from heated rock salt. The common opinion that rock salt is equally diathermanous for all descriptions of heat is therefore untenable. The fourth group of experiments shows that heat from thick plates of glass, mica, or rock salt is more easily transmitted by screens of the same nature as the heated plate than heat from thin plates of these materials. It was shown that all these experiments may be explained by Prévost's theory of exchanges, somewhat extended. This extension consists of the following laws:—1. Each particle of a substance has an independent

radiation of its own equal in all directions and without regard to the distance of the particle from the surface of the body. 2. The radiation of a particle equals its absorption, and that for every description of heat. 3. The flow of heat from within upon the interior surface of a polished plate of indefinite thickness is proportional to the index of refraction of the body, and that for every description of heat.

The bearing of these experiments on Dulong and Petit's law of radiation was then attempted to be traced. It was shown that unless bodies from simply being heated change their transmissibility for the same description of heat (which there is no reason to suppose), the radiation of thin plates or particles at a high temperature will bear a less proportion to the total radiation of that temperature than at a low,—the consequence will be, that the radiation of single particles will increase with the temperature in a less degree than Dulong and Petit's law would indicate. It may even be that the radiation of a particle or very thin plate may be proportional to the absolute temperature of that particle. Taking a piece of glass or mica, therefore, at a low temperature, as it is very opaque with regard to the heat radiated by itself, we may suppose that the total radiation consists of that of the outer layer of particles only, that from the inner layers being all stopped by the outer. At high temperatures, however, we may suppose that there is not only the radiation of the outer layer, but also part of that of the inner layer which has been able to pass, swelling up the total radiation to what it appears in Dulong and Petit's experiments. This way of looking at radiation may possibly bring the radiative power of particles to obey the same laws with the conducting power of particles, which Prof. Forbes has shown decreases with an increase of temperature. The author of this communication is indebted to Prof. Forbes for the use of the instruments and substances employed, and also for many valuable suggestions with regard to the experiments it contains.

11. *On the Phosphorescent Appearance of Electrical Discharges in a Vacuum made in Flint and Potash Glass;* by Mr. J. P. Gassiot, (Proc. Brit. Assoc. Ath., 1615).—The discharge from an induction coil when taken in a vacuum tube made of flint glass, has (under certain conditions) the property of rendering the glass highly phosphorescent, the phosphorescence being denoted by the intense blue color of the glass with which the stratifications are surrounded. On trying the discharge in some vacuum tubes I had obtained from Mr. Geissler, of Bonn, I observed that the phosphorescence was no longer blue, but was of a slight green color. To test whether this difference was due to the gaseous matter remaining in Geissler's tubes, or to the character of the glass which he uses, I had Torricellian vacuums prepared in German glass tubes, and in this manner ascertained that the difference in the color was entirely due to the character of the glass: that of Germany is, I believe, made with potash, and is entirely free from any lead, while in the English flint glass lead is introduced to some extent. I have recently obtained a vacuum tube from Bonn, which shows this difference in a very beautiful manner: the outer ends of the tube are composed of German glass, the centre of the tube is of English glass; by this arrangement the contrast between the two is very manifest.

12. *On Induced Electric Discharges when taken in Aqueous Vapor;* by Mr. J. P. Gassiot, (Proc. Brit. Assoc. Ath., 1615).—If the tube of a well constructed water-hammer is partly covered with two separate coatings of tin-foil, and the coatings are connected one with the outer, and the other with the inner terminal of an induction coil, a discharge will be observable through the centre of the tube in the form of a wave line. On repeating this experiment I ascertained that the vacuum in the tube was very much deteriorated. I could no longer produce that peculiar bubbling in the ball of the apparatus which is always attainable by gently heating the tube with the warmth of the hand; this bubbling was originally very sensibly perceptible in the tube I now exhibit when I first received it from the maker, Mr. Casella. I have repeated the experiment with other water-hammers, and always with the same result; but I have not yet opened one to examine whether the vapor has been decomposed, and gas evolved.

II. GEOLOGY.

1. *On Marcou's "Geology of North America;"* by Prof. Agassiz.—I have not yet seen Marcou's latest publication on American Geology, but I have now open before me, his paper in the Proceedings of the Geological Society of France, and that in Petermann's "Geographische Mittheilungen," both bearing date 1855, as well as the Geological Map of the United States and British North America by H. D. Rogers, also bearing date 1855, and Hall's and Leslie's Map of the country west of the Mississippi river, published with the 1st vol. of Emory's Report in 1857. I take it that it will be no injustice to either Rogers or Hall to go to an earlier publication of Marcou's, in a comparison of their respective claims to correct illustration of our Western Geology. Let me premise by saying that as far as the geology of the East is concerned, from Iowa to the Atlantic coast, I acknowledge that to Hall is due, unquestionably, the credit of having settled by extensive comparisons, and by personal examinations, the true geological horizon of the vastest extent of our continent, not only by an examination of the superposition of the rocks, but also by the most minute and most extensive study of the fossils.

We all know also how much the Rogerses have done to elucidate the physical geography, the orography, and the order of succession of the formations of Pennsylvania and Virginia, which has thrown much light upon the general geology of the eastern part of the continent. It is equally well known how much the special state surveys have added to the details in this general investigation of the Geology of North America. But when we go west of the Mississippi valley to the Pacific shores the case is very different. The maps of Rogers, Hall and Marcou, are a compilation and an attempt at coordination of surveys which cover only a very small portion of the ground. They are, as it were, the reading of the authors of these different maps, of investigations made by others, though Marcou has here unquestionably the advantage of having gone himself over the ground.

A comparison for instance, of the manner in which the volcanic rocks are dotted over New Mexico, Sonora, and Lower California, as well as in California, Oregon and Washington Territories by Hall and Rogers,

with Marcou's representation of the same cannot fail to show to a geological reader, that they are more natural in Marcou's map than in the two others. When a region is not more minutely surveyed than the whole western half of our continent, of which we have not even accurate geographical maps, it is not possible to expect accuracy in detail, and the critic must consider the general connection rather than special points.

I do not see, for instance, how the omission of State boundary lines which, in a former review of Marcou's map in the Journal, was made a prominent objection to his representation of American geology, can be of any importance in such a general survey of the subject. Rogers in his map does not give these boundaries any more than Marcou.

But I now come to the essential point. What is the true geological character of those five hundred thousand square miles of land, extending between the Mississippi, west of Arkansas and Missouri, and the great Salt Lake Basin? Rogers colors it uniformly with Cretaceous rocks, and the well known Tertiary deposits, adding metamorphic rocks, flanked with Carboniferous in the mountainous tracts. Hall does the same only making in addition, a distinction between the upper and lower Cretaceous, while Marcou distinguishes further between Permian, Triassic and Oolitic beds. I do not suppose that he, any more than Hall and Rogers, imagines that the boundaries he assigns to any of these groups are any more accurate than those assigned by Rogers and Hall to the groups they distinguish. These appear to me simply in the light of the respective readings of isolated facts recorded in the way they have struck the authors of these different maps. When in his paper to the Geological Society of France, Marcou speaks of himself as a travelling geologist who "brings his little stone to the great edifice" (page 3) it does not appear to me as vain-glorious boasting, and we ought to take gratefully the contributions of a Frenchman, using language after the fashion of his nation, even though it be not the way in which we would have expressed ourselves. Now I confess that after reading the condensed Review of American Geology which Marcou has given, in Petermann's Contributions, I find in it a more comprehensive account of the general features of the orography and geology of the Western half of our continent, than in the other representations I have read upon this subject. I think that even now a translation of that paper would be welcome to every English student of American geology, and that far from circulating false impressions, it would greatly contribute to bring before the mind the grand features of that remarkable country, and to connect in an intelligible way the geology of the West with that of the East. The middle tract of our continent is unquestionably occupied by deposits younger than the coal; I do not allude to the Lake Superior Sandstone respecting which I believe Marcou to be mistaken,—but the five hundred thousand square miles of questionable character as to the details, certainly belong to those from recent formations.

Now it appears to me that the geology of our Atlantic States furnishes data upon which theoretical inferences, bearing upon the question which Marcou's assertions call forth, may be founded. We know that the Cretaceous formations extend from the Atlantic slope of the Alleghany range round their southern spur into the great geological gulf

now occupied by the Mississippi valley. We know further that along the eastern slope of the Alleghanies, beginning with the Connecticut valley, there extends, between the axis of elevation of that chain and the Cretaceous deposits at its Atlantic foot, a series of deposits referred respectively to the Triassic and the Oolitic series.

We know also that to the south of North Carolina, these lower secondary deposits are covered over by the Cretaceous. Now, since the upheaval of the Alleghanies is anterior to the deposition of the Trias, does it not appear natural to suppose that Triassic and Oolitic formations must have been deposited at the foot of the western slope of the Alleghanies as well as upon its eastern slope, and that the Cretaceous deposits overlap them in the Mississippi gulf in various ways, as along the Alleghany chain, and that, following various routes, the different geologists who have gone across the continent must have seen, here Trias, then Jura, and then again Cretaceous beds, overlaid by Tertiaries, in a number of points, already determined, though the relative extent of all these beds, over a surface of 500,000 square miles, remains yet to be ascertained.

The circumstance that Marcou has colored in yellow the whole middle tract of the continent, can express nothing but his conviction that the whole Mississippi gulf is lined with Triassic beds, overlaid with more or less extensive Jurassic, Cretaceous and Tertiary deposits. In such a theoretic representation of the geological features, where the details are wanting, provided the existence of the Trias and Jura is made out somewhere, there is no more inaccuracy than in coloring a map of our eastern geology, where the drift covers the greatest extent of the surface, as if it were altogether occupied by Palæozoic rocks.

I take it that such things are, by this time, understood by all those who examine schematic maps,—at least they should be. Moreover, the discoveries by Professor Swallow and Mr. Meek of Permian beds in Kansas, along the eastern border of the great Mississippi gulf, and by Professor Hall in Iowa, furnish a very unexpected confirmation of the broad statement first made by Marcou, that while the Eastern part of our continent consists of Palæozoic rocks, the middle part is occupied by the Mesozoic series. I truly believe that, at some future period, the general outline of our western geology by Marcou, which by the way, has the priority over the others, will stand before a complete survey of the whole in the same light as Maclure's old map now stands, when compared to the well-known eastern geology.

In this connection, I cannot but remember that, with Thurmann, Mandelslohe, Gressly, Quenstedt, Römer, d'Orbigny and Oppel, Marcou is one of the geologists who knows the Jurassic formation best; that he has published a masterly paper upon the Jura Salinois in the Transactions of the Geological Society of France; and that it seems hardly credible to me that he should have been so completely mistaken in his identification of Oolitic beds in the west. I have myself, in my collection, a large number of specimens of the Cretaceous fossils of Texas and of New Jersey, among which is a beautiful series of the Exogyra, characteristic of the Cretaceous period, and I have seen the Exogyra and the Ostrea which Marcou brought from his excursion across the continent, and I distinctly remember that I could not identify them with the Cretaceous species, but rather thought them allied to Jurassic species.

Whoever has read Marcou's paper on the Jura must have seen that he knows, as well as any geologist living, that lithological characters are of no value in identifying geological horizons. But after having presented the general evidence, as far as it goes, for the presence of Triassic and Oolitic beds in the middle tract of our continent, I cannot find that there is any reason for blame, with his familiarity with the Triassic and Oolitic rocks of Europe, in his pointing out the lithological resemblance there may be between them, any more than there is ground for blaming the American geologists who, after identifying certain beds in New Jersey as Cretaceous, have also alluded to their mineralogical resemblance with the Green Sand of Europe; for this is, after all, a remarkable fact which runs over immense tracts of geological deposits belonging to the same horizon.

Reply to Prof. Agassiz on Marcou's Geology of North America, by JAMES D. DANA.—I regret in such a case as this to have to differ from Professor Agassiz. The amount of difference is however not as great as at the first reading may appear; for an important part of the positions in my paper are untouched, and an explicit dissent from some of the views of Mr. Marcou is expressed.

The statements in Professor Agassiz's remarks to be especially noted are the following:

1. That Professor Agassiz had not read the work reviewed, but had seen the earlier papers by Mr. Marcou and examined his geological map.

2. That while, as regards the geology of the East from Iowa to the Atlantic coast, "to Mr. Hall is due unquestionably the credit of having settled by extensive comparisons and by personal examinations the true geological horizon of the vastest extent of our continent, not only by examination of the superposition of the rocks, but also by the most minute and most extensive study of the fossils;" and that while the "Professors Rogers have done much to elucidate the physical geography, the orography, and the order of succession of the formations of Pennsylvania and Virginia, and have thrown much light upon the general geology of the eastern part of the Continent,"—west of the meridian of Iowa their observations have not extended, and Marcou has thence the advantage of them.

3. That the maps of the region west of the Mississippi by Rogers, Hall, and Marcou are mainly compilations from the results of various surveys, and that Marcou in extending the colors of the Triassic formation over the 500,000 square miles of the Rocky mountains, and laying down also the Permian and Jurassic over the same region, was no more culpable than Hall or Rogers in covering it with Cretaceous.

4. That Marcou is mistaken in regarding the Lake Superior Sandstone as Triassic.

5. That it is hardly credible that Mr. Marcou should have been so completely mistaken in his identification of Oolitic beds in the west; and that the two species collected by Marcou from the beds are most allied, in Professor Agassiz's opinion, to Jurassic species.

6. That Mr. Marcou knows that lithological characters are of no value in identifying geological horizons; and that adding these characters to other general evidence for the Triassic and Oolitic rocks is not blameable.

The claims which Mr. Marcou has put forward in his work are: (1) the correct determination of the Red Sandstone of the Lake Superior region;

(2) the identification, for the first time, of the Permian over the Rocky Mountain region; (3) the same, of the Triassic; (4) the same, of the Jurassic. I have presented evidence proving, as I believe, that he was wrong in each case; and hence, that the claims of prediscovery which he is now urging over Europe are groundless. Besides this, I have pronounced the work abusive of such men as the Rogerses, Hall, Whitney, Logan, Hunt, and many others, and grossly unjust to American science and geological history, while full also of groundless personal claims. I review some of these points.

Supposed Triassic of Lake Superior.—Prof. Agassiz admits that he believes Mr. Marcou to be wrong with respect to the Triassic ("New Red") character of the Lake Superior Sandstone, and thus we do not differ as to this one of the claims.

Now this question of the Lake Superior Sandstone is the one that especially calls out Mr. Marcou's opinions of American geologists. Making these rocks, and the Connecticut river and Virginia beds, as well as 500,000 square miles of territory over the Rocky Mountains, "New Red," he is indignant that Hall, Whitney, Logan, Prof. Rogers, etc., do not follow in his track. After giving a one-sided view of opinions on the different rocks which he classes together as *undoubted* "New Red" he says:

"It is difficult to present an age of strata in a manner more ambiguous and *empatée*. *The brothers Rogers and James Hall try their best to suppress* the New Red Sandstone formation in North America; but they do not know exactly what to do with these five or six thousand feet of strata. On the Geological Map of H. D. Rogers, the New Red Sandstone is unknown in the Magdalen Islands; on the northeast of the Baie des Chaleurs it is colored as Jurassic Red Sandstone, though the *Honorable Sir William E. Logan, Chevalier of the Legion of Honor*, calls it Carboniferous Sandstone. In Prince Edward Island, Connecticut valley, New Jersey, Pennsylvania, Maryland, Virginia and North Carolina, the New Red is colored as older Mesozoic (Jurassic coal and Jurassic red sandstone). In Lake Superior it grows older, and the New Red is colored Cambrian, (Primal, Auroral and Matinal). In the Praries, Texas, Rocky Mountains, New Mexico, etc., the "New Red," that seems to change its age with Protean facility, has once more renewed its youth and is colored as Cretaceous, and sometimes also as umbral and vespertine, or in ordinary language as Lower Carboniferous.

"*They have not thought of putting the New Red in the Upper Silurian or the Tertiary. I would advise these honorable savants to consider if one of these determinations would not be preferable.*"

The *jumble* here is of Mr. Marcou's making, and it comes of his own errors about the "New Red." We let the style of criticism go without remark, satisfied for the present with italicizing only some of the more characteristic parts.

While on this topic, Mr. Marcou, noticing that Dr. D. D. Owen had within a few years taken the same ground with Prof. Hall and other geologists, says, "why Owen changed his views is quite a mystery." He will now regard the case of Dr. Owen not the only mystery.

Permian of the Rocky Mountain Region.—I pointed out in my review that Mr. Marcou had distinguished as Permian, rocks that contained fossils which he set down in his *Field notes* and *Resumé* with a query as a *Belemnite* and a *Pteroceras* (the latter word changed in the recent work to *Gasteropod*), although no Belemnite or Pteroceras is known to occur below the lower Jurassic (Lias). Disregarding or defying the hints from the imperfect fossils, he made the beds Permian on *lithological characters* and superposition alone.

On the Permian of Mr. Marcou, Professor Agassiz says nothing. The use made of lithological characters in its determination is far from sustaining the opinion cited above in paragraph 6.

Triassic of the Rocky Mountains.—My review states that Mr. Marcou established the existence of the Triassic on one fossil, and that an uncertain species of pine wood: this one doubtful fossil wood, and the *lithological characters* make up the evidence in favor of the discovery: and on *lithological characters* and superposition alone he based his queried subdivision of it, into *Bunter*, *Muschelkalk*, and *Keuper*—thus again badly misusing lithological evidence. He mentions also the discovery of a *Cardinia*, but says that Cardiniæ occur in rocks from the Jurassic to the Carboniferous.

Professor Agassiz brings forward nothing against my conclusion that the Triassic was not identified in the Rocky Mountains by Mr. Marcou.

Jurassic rocks in the Rocky Mountains.—The evidence which I cited that Mr. Marcou's Jurassic is really Cretaceous, was based on the determination by Hall, Conrad, Shumard, and others, that his supposed Jurassic fossils are Cretaceous, and that they occur at localities in the west along with known Cretaceous species. Morton's figure of the *Gryphea Pitcheri* (Morton) I understand was made by Conrad, so that Conrad is certainly good authority as to the identity between it and Mr. Marcou's species. Dr. Newberry, who has recently returned from the Rocky Mountains confirms these conclusions; for he says (see this volume page 33):

"I may say in confirmation of the assertion that your fossil plants [species of Alder, Beach, Credneria, Ettingshausinia, &c.] are Cretaceous, that I found near the base of the yellow sandstone series in New Mexico, considered Jurassic by Mr. Marcou,—a very similar flora to that represented by your specimens, one species at least being identical with yours, associated with *Gryphæa*, *Inoceramus*, and *Ammonites* of lower Cretaceous species."

With such evidence, even the exact identification of the two fossil shells is of little importance. The Cretaceous is the lowest formation in which leaves of any dicotyledons have been found.

Professor Agassiz states that Mr. Marcou is a good Jurassic geologist. But this does not affect the case in hand. For he had but two or three fossils about which to use his Jurassic judgment; and if this judgment has pronounced fossils to be Jurassic that really occur in the west associated with Cretaceous species, or if his knowledge of rocks in Europe has led him to think he can tell Permian, Triassic, or Jurassic rocks by their lithological characters, when he sees them in America, it has served him badly.

We regard it therefore as still true that Mr. Marcou's Triassic of Lake Superior, is not Triassic; and in the Rocky Mountain region, his Permian is not proved to be Permian, his Triassic not Triassic, and his Jurassic not Jurassic. Where are then his discoveries?

Map.—As regards the geological map-making, there is little resemblance between the cases of Rogers and Hall and Mr. Marcou. The former do not claim to be discoverers over the Rocky Mountain region, and Mr. Marcou does. Mr. Marcou, while remarking that the colors to the north and south of the course he followed are only approximative, says, "*I am sure of the limits of the formations on the line I have explored near the 35th parallel of latitude;*" and guided by this *sure* determina-

tion, he marked the Triassic on his map, and then, at a hazard, influenced by his views of earlier explorations, he spread the Triassic color far north over the 500,000 square miles. Now if his identification of the Permian and Triassic was in each case an error, what shall we say of the 500,000 square miles? and what of his map, if this is all wrong, and in addition his identification of Triassic in the Lake Superior region? He cannot rightly shield himself behind any geologist, or the common usage of following the best compiled results for fixing the lines.

Theoretical inferences may be good by way of suggestion; but too eagerly followed they lead to just the errors Mr. Marcou has made. But his system for the West has not even the show of probability in its favor. It is well known, and Mr. Marcou admits it, that Cretaceous fossils and rocks occur about the very summit plains of the Rocky Mountains. The natural inference is, therefore, that when in Cretaceous times these summits were under water, the sea also extended over what are now the eastern slopes of the mountains, and might have covered them with Cretaceous beds: and that thus the Cretaceous should be expected to be the surface formation, (it is understood that the question relates to the *surface* formation, as the colors refer in all cases to this,) and that any Jurassic, Triassic, and Permian, if they exist, should be covered up by it. This, I say, is what should naturally be expected. Moreover, this is what all researches since Mr. Marcou was over the region are tending to prove; they sustain Hall and others in coloring the greater part of the Rocky Mountain slope Cretaceous. The inferior beds, as the Palæontologist quoted from in my paper states, may be looked for as outcropping beds about the base of the ridges or crests of the mountains. Mr. Marcou's map is hence not only at variance with recent researches, but also with reasonable views of western geology.

We cannot see therefore that Mr. Marcou's claims as a discoverer are in any one case sustained, or that his merits are in any respect enhanced by his American researches. And we certainly should not go to him for an exposition of American geology.

Professor Agassiz knows well our American geologists and appreciates their labors; and he writes about them in a different style from Mr. Marcou. But on this point it is not necessary to dwell.

2. *On some points in American Geological History;* by Prof. James M. Safford, of Tennessee.—The Lower Silurian rocks of East Tennessee afford several very interesting local beds. Among them there are two which I desire to mention with reference to their bearing upon American Geological History. The first and oldest is a bed of crinoidal variegated Marble: the second is a bed of sandy *ferruginous* Limestone of peculiar aspect. The Marble (measured not far from Knoxville) is nearly 400 feet thick; the ferruginous bed is thicker and sometimes rests upon the former, but is generally separated from it by a few feet of calcareous shale. The whole is overlaid by limestones and calcareous shales of the Hudson period.

The geographical extent and range of these beds is peculiar, and to my mind, indicates the early Silurian age of the Appalachian oscillations. It is easily shown, that, before they had partaken of the later and Appalachian movements, these beds were long and narrow belts stretching to the

northeast and southwest. The Marble, for instance, ran from Virginia, through Teneessee, to Georgia, a distance of more than one hundred and fifty miles. How much further it extended lengthwise beyond the limits of Tennessee, I know not. Yet with this length its greatest breadth was not more than twenty miles. There can be no question as to the belt-like character of this bed when *first* deposited. Although broken and dislocated by after movements, the original thinning out of the bed laterally is clearly seen in good sections.

The ferruginous bed commenced within the limits of Tennessee, a few miles above the present site of Knoxville, and ran down into Georgia. Its length in Tennessee was not less than 100 miles. How far it extended southwestward into Georgia, I have not ascertained. It covered a somewhat wider area than the marble, but had very much the same long belt-like character.

To what now is the long narrow form of these beds to be attributed? and why did they, or do they, conform in direction to the great Appalachian folds? and why did they thin out on both sides much after the same manner, there being, at this period, no greater indication of dry land on one side than on the other? It appears to me that your view of the Silurian age of the Appalachian oscillations will alone satisfactorily account for these characters. By them the sea-bottom was arranged (perhaps in a long trough) first for the crinoidal grove, the remains of which, together with small corals, (Chaetetes,) form the Marble bed. Afterwards by other oscillations the bottom and the sediment were prepared for the ferruginous bed, &c.

There are other facts bearing upon this subject, which I have observed in the Lower Silurian rocks of East Tennessee, but which time will not permit me to refer to at present.

3. *Post-Pliocene of Lewiston, Maine.*—Mr. W. W. Baker gives an account in the Proceedings of the Boston Soc. Nat. Hist., 1858, p. 394, of the occurrence of a fossil starfish in a hill of earth, 30 miles from the sea, 200 feet above its level, 100 feet above the level of the Androscoggin, which is half a mile off, and 10 feet below the present level of the surface. The hill is clay for eight feet, then thin layers of sand, gravel and clay, alternating. The species according to Mr. Bouvé, was the same as the living species of the coast. There were also numerous impressions of shells.

4. *Untersuchungen über die Entwickelungs-Gesetze der organischen Welt, während der Bildungs-Zeit unserer Erd-Oberfläche*, by Dr. H. G. Bronn: 502 pp. 8vo. Stuttgart, 1858.—This work is a general review of the progress of life in the course of geological history. It received the prize from the French Academy in 1857.

5. *Further Contributions to the Palæontology of the Tilestones or Silurio-Devonian Strata of Scotland;* by Mr. D. Page, (Proc. Brit. Assoc., Ath., No. 1616).—Without entering on the stratigraphical relations of these tilestones (which would be discussed at a subsequent meeting), he might simply mention that part of them, as in Lanarkshire, seemed to cap and form portion of the Upper Silurians, while the larger portion, the Forfarshire flagstones, undoubtedly constituted the basis of the Old Red Sandstone; hence, with a view to avoid all discussion in the mean time, he had ranked the whole as "Silurio-Devonian." Beginning

with the Lanarkshire beds, he had, since the Glasgow meeting, been enabled to add several new forms to the fossil Fauna of that district, for hitherto no trace of vegetation had been detected in the strata. In addition to *Trochus helicites* and *Lingula cornea*, which were then known, he had now to add Pterinea, Orthonota, Nucula, Avicula, Orthoceras, and other well-marked Ludlow or Upper Silurian shells. To the Crustaceans then known, viz., Beyrichia, Ceratiocaris, and Himanthopterus, he had now to add several discoveries which rendered the structure of these curious crustaceans more apparent, besides the detection of two entirely new forms, which he would venture to term provisionally *Eurypterus spinipes* and *E. clavipes*, in allusion to the characteristic form of their swimming paddles, or third pair of organs which spring from the under side of their cephalothorax. Turning to the Forfarshire beds, which in 1855 were known to yield little more than obscure vegetable forms, *Parka decipiens* of Lyell, Pterygotus, and Cephalaspis, he was now enabled to add several new and gigantic forms of Fucoids, a Cyclopteris, and a Lepidendroid stem, which was clearly of terrestial origin. To the Fauna he has added gigantic Scolites or annelid burrows, Serpulites or annelid tracks, and an organism which appeared to be the remains of an annelid itself. There had also been discovered several new portions of Pterygotus, which rendered the true structure of that gigantic crustacean much more apparent; and he had also been enabled to describe and figure two new crustaceans under the names of Kampecaris and Stylonurus, the latter closely related in structure to Eurypterus, and approaching the forms of those found in the Lanarkshire strata, To Cephalaspis, of which little more was known than the head and bony ring-plates of the body, he had now to add a well-marked corneous eye-capsule, a pair of pectoral fins, a dorsal fin, and the true form of the large heterocercal tail,—so that, instead of figuring this much-caricatured fish as had hitherto been the case, as a saddler's knife for the head, and a parsnip with a few radicles for the body, we could now restore it as a legitimate and elegant fish, much resembling in general contour the armed bullhead or Aspidophorus of our present shores. There had also been discovered a vast number of fin-spines or Ichthyodorulites, which were yet undescribed, and a small fish with fin-spines and shagreen-like scales, to which he had given the name of *Ictinocephalus granulatus*, in allusion to its kite-shaped head and shagreen-covered body. For the discovery and preservation of these new fossil forms, palæontologists were mainly indebted to James Powrie, Esq., of Reswallie, Forfar, and to Mr. Slimon, surgeon, Lesmahagow, to the latter of whom the British Association, on the representation of Mr. Page, has given a grant of 20*l*., to assist in prosecuting his researches among these interesting but as yet partially explored strata.

III. BOTANY AND ZOOLOGY.

1. *Nereis Boreali-Americana; or Contributions to the History of the Marine Algæ of North America;* by WILLIAM HENRY HARVEY, M.D., M.R.I.A., F.L.S., Professor of Botany in the University of Dublin, etc. Part III. *Chlorospermeæ.* (Smithsonian Contributions, for 1858). Pp. 140, tab. 37–50, imp. 4to.—Our readers are familiar with the first part of this elaborate work, containing the *Melanospermeæ* or olive-colored

Algæ, and with the second, the *Rhodospermeæ*, or rose-red series. With the *Chlorospermeæ*, or proper green Algæ, Dr. Harvey has now completed this extensive undertaking, and furnished us with a manual of the highest character, by which the marine Algæ of our continent,—and also a good part of the fresh-water species—may be readily studied. Great praise and cordial thanks are due to Dr. Harvey for the prolonged and assiduous labors which have fairly opened this wide and difficult field to the American student; and likewise to the Smithsonian Institution, for its enlightened liberality in the publication, not only presenting copies to all the principal public libraries of the world, but placing a separate edition upon sale at a low price, which brings the work within the reach of every earnest student or zealous amateur in the country. We are gratified to learn that the enterprise and good judgment of the managers of the Institution are duly appreciated by the public; and that the work has achieved a popularity unsurpassed by any of the valuable Smithsonian Contributions to Knowledge.

No good account of the *Chlorospermeæ* could be given without some view ot the fresh-water species also. So, as many of these as was possible under the circumstances, have been included in the present memoir. But a large part of them can be investigated only when alive. Also the *Diatomaceæ* and *Desmidiaceæ*, although they systematically belong to the *Algæ*, yet they form a microscopic world of themselves, and require a separate treatment by a special monographer. The accomplished naturalist upon whom this task appeared to devolve, and who, indeed, had done much towards its accomplishment, is no more; he of whom our author feelingly writes, in the following extract.

"I must therefore leave the task of [more fully] describing the fresh-water *Algæ* of America to other hands;—to some one living among them; and having eyes fully open to the difficulties of his task, and zeal and ability to work it faithfully. And here I cannot omit a slight tribute to the memory of one in whom were combined, in no common degree, the qualifications which make an able naturalist, and who, had he lived, would probably have taken up the broken thread. I allude to the late Professor J. W. Bailey, of West Point, one of the earliest explorers of American *Algæ*, and whose very able memoirs on the *Diatomaceæ* have won for him an imperishable name in the annals of science. To me his loss is more personal than to most of his botanical friends; for, from the hour we first met there grew up between us a warm friendship, which death has interrupted, but which I trust it has not ended. He it was who first suggested to me a memoir on the American *Algæ;* he arranged with the Smithsonian Institution the terms of its publication; he supplied me with a multitude of specimens; and to his influence I owe the assistance I have received from many American algologists, who looked up to him for direction in their studies. He was, as far as the Algæ are concerned, my chief American referee, to whom I could apply when seeking information on local matters connected with this branch of study. With him I constantly associated my work, and to his approbation I looked forward as the most grateful reward of my labors; and now that he is removed, my interest in the work has sensibly flagged, and I am not sorry that it is brought to a conclusion."

A passing tribute is paid to the memory of another contributor, the late Professor Tuomey of Alabama; and his name is commemorated in one of the two new genera described in the present part. *Tuomeya fluviatilis* is a fresh water plant, resembling a *Lemanea* in external appearance, but very different and not a little curious in anatomical structure.

The other new genus, *Blodgettia*, is named for the late Dr. Blodgett of Key West, who had zealously collected the Algæ as well as the other plants of the Florida Keys.

The structure of *Blodgettia confervoides* (which is illustrated in one of the plates) is so extraordinary and unexpected, that we are tempted to copy the account of it. Briefly, the cell-wall of its unicellular joints is "formed of separable membranes, the outer of which are hyaline and homogeneous, the innermost traversed by parallel, longitudinal, anastomosing veinlets. Spores seriated in moniliform strings, developed from the veinlets of the inner cell-wall!" The following is the detailed account.

"The highly curious little Alga on which the present genus is founded so closely resembles a Cladophora that it will readily pass for one, unless it be very closely examined under a powerful microscope. Iudeed so great is the resemblance to a branched Conferva that I formerly distributed it to my friends with the manuscript name of Cladophora cæspitosa, under which it was my intention to have described it in the present work; nor did I discover my error until I commenced making sketches for the plate now given. I was then first struck by the peculiar opacity of the dissepiments; and afterwards by what looked like a compound cellular structure in the walls of the cells.

On applying a higher power, other characters came out which induced me to dissect one of the articulations, when I discovered the curious structure of the inner membrane or primordial utricle; in which (as far as I can make out) the spores are developed. To see the structure as above described, the readiest mode is to proceed as follows. Cut off a portion of one of the long cells which terminate the branches; place it on the table of a dissecting microscope, moisten it, and you may readily express the viscid endochrome, which generally contains, besides the usual starch and chlorophyll grains, a number of pyramidal crystals; but these are probably adventitious. When the endochrome has been pressed out, the structure of the inner cell-wall may be partially seen; but to see it clearly, the outer coats must be removed. This may readily be done, either by tearing, with a pair of dissecting needles, or by making a longitudinal section through the cell, when the different coats easily separate, on the section being *teased* in a drop of water. The outer coat, coats (for there are two or more, though the secondary ones sometimes elude detection, owing to their extreme tenuity) are quite transparent and structureless, as is usually the case in the walls of cellular tissue. But the inner coat offers a peculiarity of structure which I have not noticed in any other Algæ, nor have heard of its occurrence in the cells of any other plants. At first sight the membrane seems to be composed of numerous minute, elongated fusiform cellules, not unlike the wood-cells of phanerogamous plants, but totally unlike any algæ cells known to me. Careful examination has however convinced me that the appearance of cellular

structure is deceptive; and that the membrane itself is homogeneous, but traversed by slender filiments or nerves, which anastomose together, forming areolæ which look like cells. These filiments give off *free* ramuli whose apices swell into spores; and (probably) by repeated cell division produce the strings of roundish *spores*, which are so conspicuous in most of the areolæ. The appearance of the whole membrane with its spores is as if a number of the *asci* of a lichen were placed side by side; the true structure, however, I need hardly say, is widely different."

Truly nature revels in variety, in the lowest and simplest, even more than in the highest tribes of plants. *Hydrodictyon*, or the Water-net, affords another, and a more familiar illustration of this, being a viviparous Alga. While in a *Conferva* a zoospore develops into an individual which increases in dimensions by the multiplication of its cells, in *Hydrodictyon* a great number of zoospores combine to form one individual, composed of a definite number of cells which remain unchanged, until each cell gives birth to a new *Hydrodictyon* complete.

"In all stages the *Hydrodictyon* is a bag-like or purse-shaped net, with generally five-sided meshes,—each mesh consisting of a single articulation or cylindrical cell, united by its ends to the neighboring cells, ... and from first to last carrying on an independent existence. When first emitted from the parent, the young *Hydrodictyon* is of microscopic size. It grows rapidly until each articulation becomes from a quarter to half an inch in length, and half a line in diameter. Up to this period the cells are filled with a green semi-fluid endochrome, in which grains of different sizes are formed. Gradually this green matter is resolved into an infinite number of minute zoospores, which are at first spherical, afterwards ovate, pointed at one end, and which, while contained within the cell-wall, exhibit lively movements. At length these movements gradually subside, and the zoospores arrange themselves, end to end, into polygonal, commonly pentagonal areolæ; and when all the zoospores contained within a single articulation have so arranged themselves, the little net is completed before its emission or birth. When all is thus ready the parent net falls to pieces, each articulation floating separately; and shortly afterwards, on the bursting or deliquescence of the wall of the mother-cell, the little net work floats independently, and commences its career of growth and development."

Here only the spores or germs are active; the developed plant vegetates quietly. But in the Oscillatorias, which are described a little further on, the mature plant exhibits very *animated* movements. "Some have a rapid progressive and regressive movement, by which they can change their place, rising or falling in the water; others, while remaining nearly in one place, move from side to side, describing an arc. The genus *Oscillatoria* is so named from the pendulum-like movements of its filaments. Species of this genus are to be found in most pools of stagnant water, and their peculiar movements may be easily observed. These plants occur, when fully developed, in floating, skin-like, slimy pellicles, of a deep green, or blackish, or bluish-color, and a gelatinous substance. If a small portion of the floating scum be placed in a cup of water, and allowed to remain for some hours at rest, its edges will become finely fringed with delicate, radiating threads, which extend further and further

from hour to hour..... The filaments have merely spread out, not grown, by means of their peculiar movements. These movements are of three kinds; first, there is the oscillating movement, one end of the thread remaining nearly at rest, while the other sways from side to side, sometimes describing nearly a quarter of a circle in a single swing. Secondly, the tip of the filament has a minute movement, bending from side to side, like the head of a worm; and thirdly, there is an onward movement, probably the result of the two former. It is this latter which causes the filaments to radiate, and spread out from the edges of the stratum."

But we must refer the curious reader to the work itself, which, though framed on a systematic and strictly scientific basis, is yet replete with physiological matters of general interest. We could have wished for a detailed account of the recent discoveries, by Pringsheim and others, of the sexual fertilization of the spores of the lower Algæ, which takes place in a variety of wonderful ways. Reference, however, is made to the original memoirs, of which, indeed, some abstracts have been given in former volumes of this Journal.

The plates, although, from the nature of the subjects, not as showy as those of the second part, are handsome and admirable. A. G.

2. *Species Filicum; being descriptions of all known Ferns. Illustrated with plates;* by Sir WILLIAM JACKSON HOOKER, K. H., &c. London: 1858. William Pamplin. Parts VII and VIII, or Vol. II, Parts III and IV. 8vo, pp. 250, tab. 111–140.—The publication of this work is resumed after an interval of six years. This delay, we are told, "has been a source of great regret both to the author and to the publisher, and has been, in a measure, occasioned by the great difficulty and labor of the subject in hand,—especially in a genus so extensive as that which occupies nearly the whole of the portion now issued, viz., *Pteris.*" Besides *Pteris* the author has here elaborated *Llavea*, *Cryptogramme*, *Pellæa* and *Ceratopteris*. *Llavea* consists of a single Mexican species separated from *Pellœa* by habit rather than by any characters of fructification. *Cryptogramme* is also considered as monotypic, *C. crispus* being made to include the East Indian *C. Brunoniana*, and the North American *C. acrostichoides*. The older name of *Allosorus* is rejected both for this genus and for *Pellæa* on account of the vagueness of its character, as originally drawn up by Bernhardi; '*Sporangia cathetogyrata, sessilia, sub-aggregata. Hyposporangia sub-communia, margine libero, sub-pellucida;*' and because it "has been made a receptacle for Ferns of very varied structure, according to the different views of authors respecting the limits of the genera, especially of those included in this work under the name of *Pellæa.*" The genus *Pellæa* was proposed by Link in 1841, adopted by Fée, in his Genera Filicum, and here accepted by Sir William Hooker. It includes thirty-three species, of which one third are found in the United States, viz., *P. gracilis* in the Northern States; *P. atropurpurea* from Vermont to Texas; *P. Bridgesii* and *P. densa* in California; and *P. cordata*, *P. flexuosa*, *P. andromedæfolia*, *P. pulchella*, *P. Wrightii*, *P. longimucronata* and *P. Orithnopus* in the region between Texas and California. The last three species are probably but forms of one, which must bear the name of *P. mucronata.* [*Vide Botany of Mexican Boun-*

dary Survey.] Under the genus *Pteris* the author remarks: "It will be seen from the characters and the references given, that I have taken the bold step, and what many will consider a retrograde movement in botany, in restoring almost entire the original Pteris of Linnæus and Swartz and Willdenow." Reviewing at some length the various modern genera, *Campteria*, *Litobrochia*, *Doryopteris*, *Heterophlebium*, *etc.*, into which various authors have divided the Linnæan *Pteris*, he concludes with the opinion that "as new light is continually being thrown upon this family of plants, it is premature to sanction the great multiplication of genera by laying stress on the nature of the venation when unaccompanied by any corresponding changes in fructification, or any marked differences in habit, and more philosophical to consider such groups in the light of sections or subgenera. The importance of the vascular structure is acknowledged; an arrangement, to say the least, equally natural, is preserved, and some degree of stability is given to names invented and sanctioned by the most illustrious botanists that ever lived." This mode of regarding *Pteris* is perfectly in accordance with the way in which *Lindsœa* and *Adiantum* were treated in the earlier part of the work, and on the whole must recommend itself to the student of general descriptive botany. The investigator of a single natural order is peculiarly liable to commit the fault of excessive subdivision, while a botanist, like Sir William Hooker, eminent in all departments of his science, will naturally take wider, not to say sounder, views of the limits of genera and species. One hundred and twenty-three species of Pteris are admitted, not including a large number of obscure species, of which no notice is taken, and the fifteen or twenty nominal species, which are reduced to the cosmopolitan *Pteris aquilina*. *Ceratopteris thalictroides*, Brongn., after having been referred to five different suborders by various botanists, and by one even excluded from the family altogether, is here associated with *Pterideæ*, not from any real similarity of structure and habit, but because no better place has been found for it. We may remark in passing, that it is not quite correct to say, as on page 155, that Agardh excluded only the *Allosori* of Bernhardi and Presl from the Linnæan *Pteris*, since in fact, he excluded all those that Swartz called "*Adiantoideæ;*" among them, *P. pedata*, the type of Mr. J. Smith's genus, *Doryopteris*. *Pteris dispar*, Kunze, in *Bot. Zeit.* 6, p. 539, is evidently the same plant as *P. semipinnata*, var. β, and should have been given as a synonyme of it. An advertisement affords the gratifying intelligence that the first part of the third volume may be expected at an early day. D. C. E.

3. *Catalogue of North American Birds*, chiefly in the Museum of the Smithsonian Institution, by Spencer F. Baird, Assistant Secretary of the Smithsonian Institution.—This Catalogue by Prof. Baird, enumerates 738 species of birds, of which all but 22 are strictly North American. All the 738 were determined from specimens, excepting 31. Wilson's work in 1814 contained 283 species, Bonaparte's in 1838, 471 species, and Audubon's in 1844, 506 species. The catalogue therefore contains nearly one-half more species than Audubon enumerated. The Catalogue is especially valuable as a list of well ascertained localities, thereby indicating the range of the species. The author's habitual care and untiring zeal in research authorize full reliance on its accuracy.

4. *Odontology*, by Prof. OWEN.—A very extended article of great value on Teeth, very fully illustrated, is published by Prof. Owen, of London, in the 16th volume of the Encyclopedia Britannica (8th edition). It takes up the whole range of vertebrates and includes both fossil and recent species among its illustrations. The wood-cuts, of which there are near 200, are excellent and highly instructive.

IV. ASTRONOMY.

Donati's Comet, or the Great Comet of 1858.—In our last number we were favored by Prof. Wm. C. Bond, of the Observatory of Harvard College, with a brief notice of this splendid Comet. In Runkle's *Mathematical Monthly*, Nos. 2 and 3, (Cambridge, Mass. Nov. and Dec. 1858,) Mr. Geo. P. Bond, of the same Observatory, has published a highly interesting and valuable account of this body. Rarely has so fine an opportunity been presented for observing the physical constitution and internal changes of a comet, and the opportunity has been well improved. The second part of Mr. Bond's paper occupies 26 pages and is enriched by numerous wood-cuts, and by two engraved telescopic views of extraordinary beauty. We cite a few passages from this important memoir, and hope that our readers will procure and read the full account.

"The interest of the telescopic view, taking all the circumstances into account, the size of the instrument, the perfect purity of the atmosphere, and the splendor of the object, have rarely been surpassed. The nucleus and the outline of its nearest envelope were visible in full sunshine with the large telescope. The head of the Comet could be seen with the naked eye at twenty minutes after sunset, at which time the second envelope was discernible with the telescope. It is most remarkable, that, with all this accession of brightness, the nucleus itself had now diminished to a diameter of only four or five hundred miles, scarcely one fifth of what it was on the morning of the 9th of September, by a very careful determination. Its volume had thus diminished to *one-twentieth* part only. The remaining nineteen-twentieths had, in the intervening period, expanded into the tail, or had gone to form the envelopes which now encircled it, by a process which has been fully illustrated in the preceding pages. But are we then to conclude that the nucleus, in the focus of these mysterious operations, had in this way expended the greater part of its substance? To this inquiry the best reply is a consideration of its subsequent condition. After several more eruptions from its surface, similar to those above described, it receded from our view about the 20th of October, with an evident *increase* of size compared with its condition two weeks before, and still shining with its accustomed intensity."

"Examined in the day time on the 5th with the highest powers which it would bear, no indication of a *phase* could be seen. * * "

"The tenth of October was the day of nearest approach to the earth, but the comet was manifestly on the wane, though expanded over a larger extent of the sky than before. Five envelopes, reckoning the exterior haze as one, could be traced through the whole or some part of their outline."

"We must add a few words on the appearance presented by the tail between the 6th and the 10th of October. At the date first named, one

of the supplementary rays, attained a distance of 55° or fifty millions of miles from the nucleus, somewhat exceeding that of the principal tail, and in a direction as usual, nearly in a line from the sun. Others less perfectly developed could be discerned near a point where the curvature of the main stream was pretty suddenly changed. On the 8th five or six transverse bands could be distinguished in the tail half a degree or less in breadth, with clear, well-defined outlines, and perfectly resembling auroral streamers, excepting that they kept their position permanently, that is, without motion sensible to the eye, they diverged from a point between the sun and the nucleus."

"The train attained its largest apparent dimensions on the 10th, when the main stream of light could be distinguished through an arc of 60°, corresponding to a length of fifty-one millions of miles, or rather more than half the distance of our earth from the sun. The distribution of its light at a distance of 20° or 30° from the nucleus in parallel or slightly diverging bands, alternating with dark spaces, was strongly exhibited. They were 5° long, and 20′ or 30′ wide, and might aptly be compared either to the streamers which often break up the continuity of an auroral arch, or to a collection of five or six tails of small comets, forming from the remains of the large one."

"The most recent intelligence leaves no room to doubt that the comet of Donati is periodical, having a time of revolution of about two thousand years. The following are the results arrived at by different computers:—

Watson,	2415	years.
Bruhns,	2102	"
Löwy,	2495	"
Graham,	1620	"
Brünnow,	2470	"
Newcomb,	1854	"

"Supposing its last perihelion passage to have occurred at the beginning of the Christian era, it must have passed its aphelion in the early part of the tenth century, at a distance of 14300 millions of miles from the sun, its velocity at that point being 480 miles an hour."

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Tables, Meteorological and Physical, prepared for the Smithsonian Institution;* by ARNOLD GUYOT, LL.D. 2d edition, revised and enlarged. Washington, Smithsonian Inst., 1858, 8vo.—The full value of this extensive and important collection of tables it is impossible to exhibit without a detailed catalogue, which our limits do not permit. They are selected from a wide range of authorities, by a gentleman who is well known for his thorough acquaintance with the best sources of knowledge on these subjects, and for his faithful and exact computations. The amount of labor demanded for the preparation of the work must have been great, and the scientific men of all countries are under weighty obligations to the accomplished editor, and to the Secretary of the Smithsonian Institution for making accessible at so cheap a rate, so precious a collection of auxiliary tables.

A first edition of part of these tables appeared in 1852. More than three times as much matter is contained in the present volume, as in the former issue.

The work now comprises six series of tables, viz.:

I.	Thermometrical,	15 tables, in	35 pages.
II.	Hygrometrical,	33 " "	165 "
III.	Barometrical,	28 " "	134 "
IV.	Hypsometrical,	26 and 44 "	149 "
V.	Meteorological Corrections,	99 tables "	120 "
VI.	Miscellaneous,	6 " "	12 "

The following remarks are made by Prof. Guyot in respect to the construction of these tables:

"In the Thermometrical series six small tables have been added; they were prepared for converting into each other differential results given in degrees of any one of the three thermometrical scales, irrespective of their zero point.

"The Hygrometrical series has been entirely reorganized. It only contained five tables, all in French measures, and the appendix. It is now composed of twenty-seven, arranged in three divisions. In the first are found ten tables, based on Regnault's hygrometrical constants, both in the psychrometer, the dew-point instruments, and for computing the weight of vapor in the air. The whole set in English measures, and Table V in French measures, have been prepared for this edition. Being based on the best elements we now possess, they are given here for ordinary use. The second division contains the seven most important tables published in the *Greenwich observations*, and Glaisher's extensive Psychrometrical Table. These tables being much used in England, and the results obtained by them exhibiting no inconsiderable differences from those derived from the preceding ones, they are indispensable for comparing the results. The third division, composed of ten miscellaneous tables, furnishes the means of comparing the different values of the force and the weight of vapor, especially those which have frequently been used in Germany, and also of reducing the indications of Saussure's Hair Hygrometer, to the ordinary scale of moisture. The appendix remains as in the first edition, but all the tables have been revised and corrected.

"The barometrical series now in four divisions, has been increased from twelve to twenty-eight tables. Excepting three small tables for capillary action, all the new ones have been computed for this edition. The comparison, now so much needed, of the Russian barometer with the other scales, appears here for the first time.

"The Hypsometrical series is almost entirely new. It contained only Delcros's table for barometric and Regnault's table for thermometric measurements, besides two auxiliary tables and the thirteen small tables of the appendix. It now offers twenty-three tables for barometrical measurement of heights, in which all the principal formulas and scales are represented; three for the measurement of heights by the thermometer, in French and in English measures; and a rich appendix of forty-four tables, more extensive and convenient than those in the old set, which afford the means of readily converting into each other all the measures usually employed for indicating altitudes.

"The series of Meteorological corrections for periodic and non-periodic variations, for all parts of the world, mostly due to the untiring industry of Professor Dove, is an addition which will surely be appreciated by those who know how difficult access to the original tables is for most meteorologists. A few tables have been added to Dove's collection, computed by Glaisher, Captain Lefroy, and by myself. Most of the tables refer to temperature, only two to moisture. Two tables of Barometrical corrections have been placed in the Hypsometrical series, where they were needed, until they can be joined by others to make a set in this series, which still awaits new contributions, especially for these two last departments."

2. *On the Heating of the Atmosphere by Contact with the Earth's Surface;* by Prof. Hennessy, (Proc. Brit. Assoc.. Ath., No. 1616).—The temperature of the atmosphere depends principally on the heat which it receives from the sun and on what it loses by radiation. A portion of the solar heat is absorbed in passing through the air, while another portion penetrates to the earth's surface. The ground becomes thus heated, and the lower strata of the atmosphere acquire the greater part of their heat from contact with the warmed surface. It is admitted that the mode in which the air becomes heated by contact with the ground must be a kind of circulation analogous to that seen in the movements of a heated mass of liquid, such as boiling water. When studying the vertical movements of the atmosphere, with reference to which Prof. Hennessy had made a communication to the Association last year, he had been led to consider the connexion between such movements and the influence of the heated ground. In order to experimentally study the question, thermometers were suspended at different heights above the ground, and under different circumstances of exposure to the influence of the supposed currents. Observations were made every minute, and sometimes every half minute, during short intervals, about the middle of the month of May, on days when the sky was clear, and during which there was consequently a great deal of solar radiation. In general the thermometers exhibited fluctuations of temperature, the intensity of which diminished the more they were protected from the influence of circulating currents in the air. The greatest fluctuations were presented by thermometers with blackened bulbs exposed in the sun. This arose from the circumstance that the blackened bulbs, by acquiring a high temperature, became themselves disturbing agents in the calorific conditions of the surrounding air. Evidence of similar phenomena appears to be presented by the curves of temperature obtained by the aid of photographical registration at the Radcliff Observatory in Oxford. Attention has been called by Mr. Johnson to a remarkable serration in the temperature curves during the day. This serration is found only when there is a considerable amount of solar radiation, it disappears during sunless and cloudy weather. While it is explained by referring it to the influence of the solar heat upon the ground, and the consequent circulation of small atmospheric currents, it affords a very satisfactory confirmation of the trustworthiness of the photographical method of registration.

3. *On the Decrease of Temperature over Elevated Ground;* by Prof. Hennessy, (Proc. Brit. Assoc., Ath., No. 1616).—He showed that the

decrease of temperature in ascending through the atmosphere depended not only on height above the sea level, but also upon the absolute height above the nearest surface of solid land. In this way the decrease of temperature over plains, mountains, and plateaus, would be necessarily very different, and we cannot immediately infer the state of the phenomena in the two latter instances from what may exist in the former. Some of the results of observations made on some of the hills and mountains of Ireland during the Ordnance Survey, as contained in the volume recently published by Col. James, were referred to as illustrations of these general views.

Admiral FitzRoy thought that one circumstance was too much overlooked by Prof. Hennessy in these researches, namely, that along with these ascending currents the whole body of the air was carried along by horizontal currents, so that it could not be assumed that it was the very same air which gave some of the indications which afforded the others. Again, it had been clearly shown that a thermometer placed upon the ground, or close to it, frequently fell 17° or 18° below one placed a few feet or inches above it, while somewhat higher up still, the indications of tho thermometer again fell, thus clearly indicating a spot at which there was a maximum temperature. As to the latter part of what he stated, it was so commonly observed that if you placed a thermometer in the lower window of a house, and another in the window immediately above it, in nine cases out of ten you would find the latter indicate a lower temperature than the former. Prof. Stevelly said that, besides what Admiral FitzRoy had pointed out, there were two other circumstances of much importance to be attended to in such observations as Prof. Hennessy had been making. First, that evaporation was going on more or less rapidly according to the circumstances of the locality where the observations were conducted. Secondly, that the air, when having,—either gradually, as in some cases, or abruptly, as in others,—to ascend in its course very elevated ground, was compelled to contract in volume, become condensed, and yet in some cases part with a portion of its vapor, and thus form the cloud which we so often saw capping the hills, as well as giving origin to the high winds and storms which so frequently prevailed there. Dr. Tyndall said that he had just returned from Switzerland, where, on the tops of Monte Rosa, and even of Mont Blanc, he had a full opportunity of witnessing these phenomena on a scale of grandeur truly sublime. The snow in these regions was naturally as dry as dust, and he had frequently an opportunity of witnessing columns of it whirled up to an immense height by the ascending currents of air, into regions where it was soon dissipated, or melted and dispersed into vapor. It was also to be observed that the sun's heat had a power of penetrating water and other screens, such as the clouds formed, far surpassing that possessed by heat derived from less intensely ignited or heated sources, as for instance, from bodies heated red hot, or from vessels filled with hot water and the like. Hence, the sun's rays, though they penetrated the clouds and the earth, yet there they totally lost their former powers, and when radiated back possessed no such power as before of penetrating clouds or other screens, and thus the earth and its atmosphere became a kind of trap for the solar rays.

4. *Death of Gen. Sir William Reid, R. E.*—Late advices from England bring us the sad intelligence of the death of this eminent man, which took place at his residence in London on the 31st of October. His departure is a loss, not merely to the country in whose service his life was spent, but to the world. His modest, unobtrusive worth, his unfaltering courage, his untiring industry, his disinterested efforts to promote the welfare of his fellow-men, and his valuable contributions to our knowledge of the winds, all demand more than a passing notice of his death.

Sir William Reid was born at Kinglassie in Fifeshire, Scotland, in 1791, and was the eldest son of the Rev. James Reid, a clergyman of the Scotch Church. He was educated at the Military Academy at Woolwich, England, and entered the British army in 1809 as an engineer, and served during the last four years of the Peninsula war, under the Duke of Wellington. He was actively engaged at the seige of Ciudad Rodrigo and St. Sebastian's. In the sanguinary assault upon the latter fortress, he headed one of the storming parties, was wounded by a musket ball, and fell, covered with blood, which streamed from his mouth and nostrils. He was supposed to be dead, but, on removing from his neck a black silk handkerchief (which, by advice of a medical friend, he had unwillingly assumed, instead of the stiff military stock), it was found pressed into the wound; and on using a little force to withdraw it, the ball came out with it, not a thread of the handkerchief having been severed. The removal of the handkerchief revived him, but the surgeons, on examination pronounced the wound mortal. Contrary to their expectations, he recovered. He was wounded four times during this war, and had three horses shot under him.

After the conclusion of the peace with France, he served on the coast of America, under Gen. Lambert, until the conclusion of the war here, when he rejoined the Duke of Wellington in Belgium, in 1815. In 1816 he served in the expedition against Algiers; was Adjutant of the corps of sappers for some years after the peace. Afterward, as a Major of engineers, he was employed in restoring the government buildings ruined in the destructive hurricane which devastated Barbadoes in 1831. While so employed, curiosity led him "to search everywhere for accounts of previous hurricanes, in the hope of learning something of their causes and mode of action, but in the West Indian histories he could find little beyond details of the losses in lives and property, and no attempt to furnish data whereby the true character or the actual courses of these storms might be investigated." While thus engaged, the first of the meteorological papers of our lamented countryman, Wm. C. Redfield, met his eye, being that published in the American Journal of Science in 1831. This he says, "was the first paper he had met with which appeared to convey any just opinion on the subject of hurricanes," and, strongly impressed that Mr. Redfield's views were correct, he determined to verify them "by carefully charting the observations made at different points." He soon became satisfied of the rotative character and determinate progress of the gales and hurricanes of the North Atlantic, as maintained by Mr. Redfield. In 1838, having been able to devote more attention to these inquiries, he published his first paper on hurricanes in the second volume of "Professional Papers of the Royal Engineers," and soon after having prepared

himself by a careful analysis of various hurricanes, he published his valuable work entitled "An attempt to Develope the Law of Storms by means of Facts, arranged according to place and time." Of this, three editions have appeared. Some years later (1849) he published a second work entitled "The Progress of the Development of the Law of Storms and of the Variable Winds, with the practical application of the subject to Navigation." By these labors, with those of Redfield, Piddington and Thom, his principal co-workers, the power of knowledge has conquered even the hurricane, and the intelligent mariner, warned by indications of the barometer, and those of the early winds of the coming storm, may securely watch its approach, and avoid, in almost all cases, its dangerous vortex, and thus sail on unharmed by the gale—even while skillfully using its outer winds to expedite his voyage.

But his meteorological labors, valuable as they have been, formed but a portion of his usefulness. In 1838 he received, unsolicited, the appointment of Governor of Bermuda. On his arrival there in 1839 he found agriculture far behind; corn and hay were imported; there was but little fruit; bitter citron trees grew everywhere; and in sight of the government house was a wide swamp. Col. Reid set the example of improvement. He grafted a sweet orange on a bitter citron tree, in front of the government house; it bore good fruit, and soon all the bitter trees were grafted. He drained the swamp, imported plows and other improved agricultural implements from New York, had plowing taught, gave prizes for the best productions, and in 1846 held a grand agricultural *fete* in a fine dry meadow field—the old swamp. In fact, he gave new spirit to the people, showed them how to work out their own prosperity, changed the face of the island, took great interest in promoting popular education, in diffusing *temperance* tracts, and so won the title of "*the good Governor*," by which he is still affectionately remembered in Bermuda. In one of the volumes of Dickens' Houseword Words, the praises of this "Model Governor" may be found set forth.

In 1846 he was transferred to the Windward West India Islands, comprising Barbadoes, St. Lucia, St. Vincent, Grenada, Tobago and Trinidad. Here also, by his firm and beneficent conduct, he gained the confidence and good will of the entire population, and devoted himself, as he had done at Bermuda, to the welfare of his people and to their advancement in agriculture, education and temperance. He removed a judge who had used his power to oppress the people, and when the home government hesitated to give him their support in this, he promptly resigned his office, and returned to England in 1848. In 1849 he was appointed Commanding Engineer at Woolwich, and commanded the engineer officers and sappers and miners at the Great Industrial Exhibition; and on the resignation of Mr. Robert Stephenson, Col. Reid was requested by the Royal Commission to become, in his room, Chairman of the Executive Committee, in which capacity he served with unremitting attention. On the closing of his service for the Great Exhibition—for which he generously declined remuneration—he received the Order of Knighthood from the Queen, and in September, 1851, he received the unsought appointment of Governor of Malta—no idle appointment, for presages of the Russian struggle were even then flashing in the eastern sky, and the

government knew the value of the man they assigned to this most responsible post. During the eventful struggle which ensued on the banks of the Danube and in the Crimea, Malta was the chief point of embarkation of British troops. In February, 1854, Gov. Reid writes to a friend in this country, "I am preparing for the Russian *storm*—the first portion of 10,000 men from England having just now entered the harbor. I must in charity believe the Czar to be mad, thus to compel mankind to begin anew to destroy each other." He continued in this post until after the close of the Russian war, receiving meanwhile the promotion to General. Near the close of 1857, Lady Reid's health, which had suffered severely from the debilitating climates of the West Indies and Malta, forced her to return to England, and Gen. Reid, resigning his government, followed her as soon as a succession could arrive. Lady Reid lived but a short time after her return, and her husband has survived her but a few months. Gen. Reid had always greatly desired to make a friendly visit to the United States, but was never permitted that pleasure. Lady Reid, with two of her daughters, spent the summer of 1845 in this country, and those who had the pleasure of meeting her will not soon forget the charm of her vivacious and intelligent conversation. Gen. Reid has left no sons, but five daughters, two or three of whom are married to officers in the military and naval service of Great Britain.

We can hardly avoid noting here the remarkable fact that the spirit of this statesman and philosopher who had done so much to illustrate the path of the winds, should pass away, almost, as it were, on the wings of one of the most extensive, rapidly progressing and destructive ocean hurricanes on record. First coming under notice at the Windward Islands about the 20th of October, it passed over Porto Rico, Hayti and the Bahamas; then recurving, its axis passed, on the 24th, nearly over Bermuda, where its violence was extraordinary; and thence for some days following, it pursued its course to the northeastward, almost or quite to the shores of Europe. No storm described by either Redfield or Reid seems to have had the enormous diameter of this. It was severely felt 700 miles eastward of Bermuda in the same latitude, while its western border grazed New York, affecting the barometer sensibly, and rolling in upon us the extraordinary tides of October 24 and 25.

5. *Journal of the Royal Dublin Society.* Vol. I. 441 pp. 8vo. Dublin, 1858.—This first volume of the Journal of the Royal Dublin Society contains a variety of valuable papers—among which, there are Captain F. L. M'Clintock's Reminescences of Arctic Travel, with a geological map and descriptions of fossils, by Rev. S. Haughton; several papers on British, Australian and South Pacific Crustacea, by Dr. Kinahan; Observations on the Climate and Zoology of the Crimea, by Mr. William Carte.

6. *Chimie appliqueé à la Viticulture et à' l'Œnolagie*, Leçons professées en 1856, par M. C. Ladrey, Prof. de Chimie à la Faculté des Sciences de Dijon, etc. 640 pp. 16mo.—This is an important volume to all cultivators of the grape as well as to those who manufacture wine from the grape. Professor Ladrey is an able chemist, and has prepared a thorough work. It treats of the growth of the vine—chemical composition of the ashes—nature of the soil—wine growing countries—fertilizers—organic matters of the vine—of grapes, their kinds, etc.—fermentation, etc.—diseases of the vine, etc.

7. *Post-Pleiocene Fossils of South Carolina;* by FRANCIS S. HOLMES, A.M. Nos. 1 to 5, in 4to, with two lithographic plates to each number. Price $2.00 per number.—This new work by Mr. Holmes, is published in the same style as the *Pleiocene Fossils*, and with similar beautiful illustrations. Figures of about 100 species are given in the 5 parts issued. The volume will be completed in 15 parts, 5 parts appearing annually. From Mr. Holmes we learn that the Post-pleiocene beds extend along the entire seaboard of the state of South Carolina, outcropping about 10 miles from the coast. At the Artesian well, in Charleston, the auger penetrated the stratum of blue mud containing Post-pleiocene shells at the depth of 21½ feet. There was first 2 feet of mud; then 2 feet or more of laminated blue sands and clays; then blue mud again, and so on for 49 feet 5 inches from the surface, when it reached the Eocene Marl. At Ashley Ferry, 10 miles northwest of Charleston, the stratum is only 1 foot thick, and rests upon Eocene Marl. The best locality is at Simmons's on Wadmalaw Sound, 10 miles from the sea-coast, as described in Tuomey's Geology of South Carolina, p. 189.

8. *The Medical Application of Electricity;* by WILLIAM F. CHANNING, M.D. Fifth enlarged edition. Boston: Thomas Hall, 158 Washington street, 1859. 12mo, pp. 242.—Dr. Channing's excellent little volume has been known for many years by its former editions. It enumerates a large number of diseases to which electricity in some form has been applied with more or less of success, with quotations of cases. In an appendix, Mr. Hall (successor to D. Davis, Jr.) gives his Illustrated Catalogue of Electromedical Instruments, so favorably known by the medical profession for their superior excellence.

9. *Treatise on the various Elements of Stability in the well-proportioned Arch, with numerous Tables of the Ultimate and Actual Thrust;* by Captain D. P. WOODBURY, U. S. Corps of Engineers. 488 pp., 8vo, with many plates and tables. New York, 1858: D. Van Nostrand.—Being No. 7 of papers on Practical Engineering published by the Engineer Department for the use of the officers of the U. S. Corps of Engineers.

10. *Maury's Sailing Directions*, Eighth edition, enlarged and improved. 383 pp. 4to, with numerous plates.

A. MALHERBE, of Metz: Monographie des Picidés, ou Histoire générale et particulière de ces oiseaux zygodactyles. This work will extend to 2 vols. fol. of text and 2 vols. fol. containing 125 colored lithographic plates and 700 figures. Only 150 copies will be published.

C. F. NAUMANN: Lehrbuch der Geognosie. Second edition, enlarged. 1st volume. xvi and 960 pp. 8vo, with 325 figures. *Leipzig*, 1858.

PROCEEDINGS BOSTON SOC. NAT. HIST., 1858.—p. 385, On the Species of Flying Fish along the coast of North America; *Weinland.*—On a new species of Skate, Goniobates, from the Sandwich Islands; *Agassiz.*—On a new species of Zeus, from Provincetown, Mass.; *Storer.*—p. 391, Notice of Dr. J. Deane; *Bouvé.*—p. 394, Fossil post-pleiocene Star fish, at Lewiston, Me.; *W. W. Baker.*—p. 395, Parasites in the American Deer; *Wyman.*—p. 396, Note on Crustacean Parasites from the Sun fish; *Kneeland.*—Feeding and Growth of the American Robin (Turdus migratorius); *Treadwell.*—p. 400, death of Dr. N. W. Cragin.

PROCEEDINGS ACAD. NAT. SCI. PHILADELPHIA, 1858.—p. 177, Description of a new Tanager, from the Isthmus of Darien, and note on Selenidera spectabilis; *John Cassin.*—p. 179, Description of a new species of Argyris; *J. C. Fisher.*—p. 180, Note on the species of Eleodes found in the United States; *J. L. LeConte.*

THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. XVII.—*The Atlantic Cable;* by GEORGE MATHIOT, Electrotypist of the U. S. Coast Survey.—(In a letter to Prof. A. D. BACHE, Supt. of the U. S. Coast Survey, dated Coast Survey Office, Washington, Sept. 11, 1858.)

As the Atlantic Cable has been laid for more than a month and the line is not yet opened to the public, it is evident that there is some great difficulty in the way. According to the newspapers the trouble is in the *recording* instruments. I fear, however, that such is not the true cause of the delay. I investigated the electrical conditions which would obtain in the cable as soon as I had procured a specimen of the material, and ascertained the electrical views entertained by the managers. From that investigation I positively predicted that the cable would be a failure unless other views of the generation and distribution of electricity should obtain in the subsequent management.

It is greatly to be regretted that the counsel of certain electricians prevailed in the construction of a cable having so small a conductor, and so thin an insulation. But now that it is laid, such as it is, at such immense labor and expense, in conjunction with fortuitous circumstances on the ocean, it becomes us to summon every aid of science and independently of theory to interrogate her *experiments* and hearken to the infallible directions which these give through the unerring calculus.

Experiment shows that an immense amount of electricity is disposed on the sides of the conductor before the current mani-

fests itself through it. Theorists attribute this delay solely to the circumstance of the electricity being thus disposed, and so leave us without a remedy. The investigations of Ohm, however, tell us that the time of conveying a given quantity of electricity between any two points is determined by the tension at those points and the resistance between, and hence we infer that if the sides of the wire must first be filled before any will pass through, then the time will depend on the quantity required, the tension at the source and the goodness of the conductor. Why should the mere circumstance of *where* the electricity is disposed cause the delay in its disposal?

I considered the electrical conditions for a submerged conductor on the first proposal for an ocean telegraph, and was so fortunate as to have a paper containing some of my deductions, published in the Coast Survey report for 1855. In that paper I described a voltaic experiment which proves that a battery requires *time* to generate the *quantity* of electricity required to produce the tension needed to overcome a certain resistance, and inferentially, that time is required for the *generation* as well as for the distribution of electricity. If you will turn to that paper you will there see foreshadowed all the present difficulties of the cable; so fully am I persuaded of the correctness of the principles there given, that I would confidently undertake to charge the cable in a very short time or extend the time of charge many minutes. In the limits of a letter I will not be able fully to lay open the principles which I conclude should govern the electricians of the cable, and fearing to intrude on your time I will proceed rapidly to elucidate the main points and describe what I would propose.

The difficulties of the "static induction" are all prevised by Ohm, and I cannot but wonder that the European electricians did not thence comprehend it; the delay of the current I thence anticipated before experiment had exhibited it. The fundamental principle of Ohm is that the quantity of electricity which passes between two contiguous particles in a given time is proportional to the difference of tension between them. Regardless of this fundamental idea of the distribution, the electricians of the cable have sought to work it as a simple problem of the conduction of a quantity through, as on fully insulated conductors (those suspended in air) instead of considering it as the problem of the charge and discharge of a Leyden jar (an unlimited number of momentary conducting lines): thus regarding the conditions of the flow of the current through the conductor, and ignoring the circumstances under which those conditions are established.

The *quantity* of electricity which a Leyden arrangement takes as a charge, is proportional to the intensity of the source, the

extent of surface, and the thinness and nature of the insulation, (the dielectric); the *time* required for charge is determined by the quantity to be conveyed, the resistance of the conductors and the difference of the tensions, and the further resistance due to a certain constant, dependent on the nature of the electric medium, (its coefficient of elasticity,) which is wholly undetermined so far, and probably can not be handled before we obtain conducting lines of many thousand miles in length, but which is so small that it may be disregarded in all practical applications of electricity: in which we may make the expression of the time the ratio of a fraction $\left(\frac{T-t}{Q+R}\right)$ where T, t, are the tensions, Q the quantity required, and R the resistance, and we certainly have the means of increasing or diminishing it to the extent of our ability to handle the generating electrical apparatus, up to the point of fusion of the conductor. By Ohm's principles, and also by the demonstrated experiments of Coulomb, when a surface charged to any given intensity is brought in contact with another surface the electricity is distributed between them and the tension falls in proportion to the combined surfaces divided by the first surface; the time to convey a given quantity of electricity into a given surface will depend therefore on the *extent* of the first charged surface and the tension of the charge, with the resistance to conduction. As the quantity of electricity flowing from S to s at any moment after contact will be $\frac{T-t}{R}$ and the time for passing the whole quantity or producing equilibrium $\left(\frac{T-t}{R}=0\right)$ will be dependent on the quantity to be passed, and as this latter is $\frac{S^2 T}{S+s}$, it is evident that the whole time for charge is dependent on the value for S as well as of s and the tension of the source; and that therefore the time in the problem of the conveyance of a given quantity of electricity from a charged surface S to a recipient surface s will be a decreasing function of S.

The Atlantic cable is a Leyden battery of over four acres of coated surface, (the surface of the conductor). The electrical arrangements for working the cable I cannot learn, but suppose they use an ordinary intensity battery of small pairs, probably having terminal plates of but a few square inches of surface: hence we have the ratio of S to s as millions almost; when this small charged surface contacts with the great one, its tension is lowered enormously, the difference of tensions is almost destroyed, consequently the quantity carried in a given time is proportionally diminished $\left(\frac{T-t}{R}=Q;\ \text{when } T-t=0 \text{ then } Q=0\right)$.

Is it any wonder under such circumstances that four or even ten seconds, as rumor states it, is required to convey into the cable the quantity of electricity required to raise the tension to the point due to the great number of elements in the voltaic generator they employ.

The electricians of the cable seem to have concluded that the tension of the terminals of the battery would continue after contact, although the demonstration of Ohm, and in fact all the analysts of the distribution, have shown that it would fall, and my experiment published in the report of 1855 has even made the decline visible to the senses; or they seem to have proceeded on the supposition that the battery would in all cases maintain a maximum intensity by generating the electricity faster than it could be carried: that is as though the terminals of the battery would maintain the tension exhibited in the open circuit. They appear to have been likewise regardless of the warning of Ohm, that in the case of the exterior conduction resistance being removed or greatly decreased, a certain additional resistance will arise from the mechanical obstruction of the chemical reagents and products, a resistance which must be determined not only for each electro-chemical arrangement but also for each mechanical construction and size. These are conditions however which do not generally affect the distribution, and sensibly affect the generation only when the battery is under circumstances for vigorous action; that such circumstances obtain when the contact is made with the four acres—circumstances which are almost equivalent to uniting the terminals of the battery with a short thick wire—is shown by Mr. Faraday's describing "a *rush* of electricity into the wire" at the moment of contact (see Phil. Mag. vol. vii, p. 199). In the general formula $\frac{nE}{R+r}=Q$ which is generally taken for the equation of the distribution, if we make $R+r=0$, Q becomes infinite: a condition which constitutes *detonation* and readily obtains to the amount of the matter present in the firing of certain mixed gases, guncotton, the fulminates and a few more substances, but which thank heaven is hindered from obtaining in the great majority of electrical actions (the multitudinous phenomena of nature) by the obstruction due to mechanical resistances. One consequence of the removal of the whole of the conduction resistance would be that when we touch a piece of oxydable metal, both the metal and finger should explode; happily the mechanical resistance prevents this, and even in the most energetic forms of the voltaic battery it is so great as to make the generation of very large quantities of electricity a matter of great difficulty.

To form an idea of the limiting power of this resistance I dusted pulverulent platinum over a plate of zinc of one square

foot of surface, and immersed it in a mixture of one part acid in five of water, and found that one pound of zinc was dissolved in fifteen minutes; this then was the measure of the maximum amount of electricity a battery of such size could generate in fifteen minutes; but the whole amount a practical construction of plates of such size could generate, would not be the tenth of that amount, and it is easily foreseen that whatever the amount might be, a cable of such length and favorable arrangements for "static induction" could be constructed that all the electricity which could be generated by a series of such pairs, in fifteen minutes, with least conduction resistance, could be disposed on its sides before it would constitute a charge, and consequently the charging of such cable with that battery would require more than fifteen minutes.

The whole quantity of electricity which any battery will generate in a given time under any given circumstances will be proportional to the size of the battery plates and the interior conduction resistance, and consequently the time required for any battery to charge the Atlantic cable will be in an inverse relation to the size of the plates—the number of pairs not affecting this: it merely determining the tension to which the charge rises; though on this latter depends the available quantity at the receiving end for recording.

A battery to charge the cable in the *least* time should have the plates of *unlimited* size: this would not be possible, neither would it be practical to have them bear any small proportion to the four acres to be charged. The minimum time however may be nearly obtained by using a sufficient reservoir to collect the electricity evolved from convenient sized plates and thus working the cable by means of an immense Leyden battery. For this purpose I would construct a Leyden jar of metallic sheets and varnished paper or silk, of several acres in extent, and connect the alternate metallic sheets with suitable bars for attaching the battery with the earth and cable. It will doubtless at once be perceived that it would take quite a time to charge such a Leyden jar—say eight acres—by the battery, and here it will be seen that the mask is up which has disguised the time of charge (the so-called *wave time*). To merely enlarge the battery plates somewhat above their present dimensions would doubtless obviate the difficulty to a proportional extent, but full enlargement should be made, for it will be desirable to work as rapidly as possible. With such a Leyden battery as I propose the tension which propels the electricity into the wire could at no time fall more than one third, and its effective power in charging the cable would be some thousand times greater than an arrangement of an intensity series of small pairs. In short, it is apparent that by such an immense Leyden arrangement and a sufficient battery

to charge it, the electricity would find its way through the conductor or through the insulation.

From the tone of the European publications I have been led to infer that they do not consider it possible to work the cable in a prompt and efficient manner by means of the battery. The slow and imperfect action of the Balaklava and some other cables seems to have early thrown a damper on the prospects for submarine lines, and the suspicion seems to have become conviction after the publication by Mr. Faraday of his experiments, together with those of M. Melloni and Mr. Clark; according to those experiments it is demonstrated that increasing the number of pairs in the battery, or increasing the "*intensity*," as this operation is often improperly called, does not diminish the "wave time" or the time for the electricity to flow through the conductor. By the experiments on the subterraneous wires of the Manchester telegraph, the time for the current to manifest itself through 762 miles of wire, was the same whether 30 pairs, 50 pairs, or any number of pairs up to 500 were used. If I do not mistake the tone of these, and all the subsequent papers on the wave time for submerged conductors, these experiments are regarded as decisive against the possibility of shortening the time by any modifications of the battery. At the results of those experiments M. Melloni appears to express astonishment, and considers it as opposed to the laws of Coulomb and others, and against the received ideas of *quantity* and *intensity*. Mr. Faraday appears to be disappointed however, he having predicted if I rightly apprehend his meaning, that the current from the greater number of pairs should have manifested itself more quickly than that from the lesser, and this nonconformity of the experiment with his predictions he attributes to the fact that while the *intensity* of the current was increased, its *quantity* was also increased, and considers with the increase in the number of the pairs, their *size* should have been diminished in order that only the same quantity of electricity in a more intense condition might have been permitted to traverse the conductor. From all this it is evident that those views offer but small prospect of the battery ever serving to work the submarine telegraphs. I cannot however, but express astonishment that any other effect on the wave time, from increasing the number of pairs, than that exhibited in the experiments of Mr. Clark should have been expected, considering that at the first moment of the contact of the battery with the insulated submerged conductor, the insulation in undergoing polarization is acting as a conductor; thus at the beginning of contact, the wire acts not only as a conductor of the capacity of its cross section, but also as though it had a solid section of the area of its whole surface, thus acting on the battery, as a short thick wire (in the case of the Atlantic cable

as a wire having a solid section of 185,000 sq. ft.) in which the resistance exterior to the battery may be considered as nothing, and the whole resistance to the generation of the electricity as being only that which lies within the battery: now taking Ohm's formula for the electric current $\frac{E}{R+r}$, in which E represents the electromotive force of the chemical affinity, R the resistance to conduction due to the materials of the battery, and r the resistance of the conductor which completes the circuit by connecting the poles of the battery, and considering the effect of multiplying the number of the elements we have $\frac{nE}{nR+r}$, and considering r as being indefinitely decreased by diminution of the length of the conductor, or by increase in its solid section, which are the conditions that obtain while the cable is receiving its static charge, we may consider it as $=0$, and remove it from the equation, and then we have $\frac{nE}{nR}=\frac{E}{R}$, in which it is evident a train of batteries in the conditions which obtain at the first moments of contact with the cable, can generate no more electricity than a single cell attached to the same conductor. It is here evident that the facts arrived at by Mr. Clark, so far from being a cause of wonderment, are but what the circumstances should have suggested, neither do they call for a modification of Coulomb's laws of induction, or a change of our ideas of quantity and intensity, as suggested by M. Melloni; much less do they indicate that a diminution of the size of the battery plates would hasten the current as suggested by Mr. Faraday. When a battery has the circuit open we conceive that the terminal plates have a tension proportional to the number of elements in the train, $T=nE$; and as the whole quantity of electricity they contain will be the product of their surface by the tension, $Q=TS$, it is evident that when the battery touches any inductive surface of great extent, such as that of the insulation of the cable, Q will be divided with it, and as S compared to that surface is insignificant, and as S is constant, T will fall enormously, as has been before shown for another purpose; now when the terminals of a compound battery, are connected with a stout wire, it is known that the tension falls to that of a single pair of plates, it is therefore evident that contact of the battery, with a large inductric surface, is equivalent to connecting with a non-resisting conductor. In this state of the battery it is evident that the electricity can be conveyed into the conductor only as fast as the battery can admit of the diffusion within, or bring the electricity to the terminals, in which case, as has before been shown, many pairs can generate no more electricity than a single pair, and consequently the tension will be below the maximum of a single pair,

in proportion to the smallness of the plates. Is it any wonder that with the feeble tension produced under such circumstances, such a long time is required for the battery to charge the cable?

For the sake of illustration I have considered $r=0$; such however is not strictly the case, the wire offers *some* resistance and the gutta percha offers some resistance to polarization, the tension of the terminal plates will therefore rise in proportion to this resistance until ultimately it reaches the maximum tension due to the number of electromotive elements in the train. If we consider furthermore that with any finite resistance the tension will rise in proportion to the decrease in the value of R, or that the extreme tensions will be inversely proportional to the internal conduction resistance of the battery—or if in the formula $\frac{nE}{nR+r}=Q$ we give to r a small value and diminish R by enlarging the size of the battery plates, so as ultimately to obtain $\frac{nE}{\frac{nR+r}{m}}=m\,Q$—we see plainly that by enlarging the number of electromotive elements in the battery, and at the same time increasing their size, any required effect can be produced on the cable.

From all the above it is evident that the time for any battery to charge a Leyden jar will be in a certain inverse proportion to the size of the battery plates; the charging of the cable is similar to the charging of the jar, excepting that it is complicated by the resistance of the wire, and the time will be a function of the internal conduction resistance of the source of the electricity. The general mathematical considerations must apply to every electrical action, whether it be produced by thermo-electricity, by chemical action, by magneto-electricity, by induction coils, or by the lightnings from the clouds. But as the battery is the only effective source of electricity, and as it is the cheapest also, reason calls for the construction of a sufficient battery, for working the cable in preference to all secondary contrivances.

No one at all acquainted with the subject will doubt that such an immense Leyden jar as I proposed above for passing our longitude signals, if charged to a high intensity, would more than all other things be fitted for affecting the cable. If the great jar were not discharged in charging the cable, it would continue steadily to work it in the transmission of messages; a jar that would remain thus continually charged would be a *generator* of electricity; such is a galvanic battery, and by increasing the number and size of the plates, the battery is made into such a continuously charged jar capable of producing any extent of effect.

I have not considered the fact that by the resistance of the wire of the cable, and the reaction of the parts which first receive the static charge, the flow of the electricity is broken up into waves, and that consequently the *whole* of the insulation of the cable does not perform its full inductive office at once. I have necessarily been confined to general principles and admitted conditions of electrical action, the deductions however are the same as though the whole inductive surface of the cable were simultaneously charged, for the degree of charge given to the first portion determines the rapidity with which the successive portions receive their charge.

The plan I propose for large plates or an electrical reservoir has advantages also for the *discharge*. Already it has been proposed and is practised I believe to discharge the conductor by making contact with the opposite end of the battery. As the plan I propose offers such greatly increased electrical conditions, it will correspondingly decrease the time of discharge.

I have no doubt that you will at once coincide with me in the correctness of the views of the cause of the slow working of the cable. I think you have previously perceived that a great fall in the tension must take place at the moment of contact, and the consequent importance of having large terminal surfaces to hold a sufficient quantity of electricity to maintain the tension. The expression by you of such views I take it is what Dr. Gould refers to in his report on the telegraphic operations for longitude.

I have already extended this letter to a greater length than consideration for your valuable time would justify; but that I may succeed in presenting the correctness of my views on this important matter of the Atlantic telegraph let me trespass on you for a minute longer, to show that these new views are in fact *old*, that all electricians acknowledge them in their writings, and that the phenomenon of the delay of the current is amongst the earliest experiments in electricity.

When the knob of a DeLuc's column is brought into contact with a gold leaf electroscope, the leaves diverge. If while the leaves are diverged the terminals of the pile are brought in contact, one with the inner and one with the outer coating of a Leyden jar, the leaves collapse, and the jar is found feebly charged; if the pile is now detached from the jar the leaves will begin gradually to diverge again; if however the pile is left in connection with the jar the leaves will after some time (several minutes) diverge again. Now the time between the collapse of the leaves and their regaining their divergence, is the time required for charging the jar, to the tension due the pile:—that is, it is the time required for that generator of electricity (the DeLuc's pile) to generate the quantity of electricity required to charge that jar to the tension due to the pile. Not a single

electrician I suppose could be found, who would question the correctness of this; all will admit that the time is dependent on the ability of the pile to generate the electricity, and the extent of the inductric surface (the size of the jar). But is not this phenomena precisely equivalent to the charging of the cable? is the DeLuc's column a poorer generator in proportion to the surface of the jar than an ordinary battery is in proportion to the four acres of cable surface? Every electrician who would have the problem of diminishing the time of charging the jar by the column, would have to resort to methods of increasing the activity of the pile, either by changing the nature of its elements, or increasing their surface; then why does not the same doctrine hold good in regard to charging that big jar, the Atlantic cable?

I have endeavored to demonstrate that submerged telegraph lines differ from the land lines in requiring batteries having the plates *very large*, because the electrical condition of the cable at the first moments of contact are such that require a battery capable of furnishing a current of great *quantity* as well as great intensity. I have, however, made no indication of the precise size or number of plates which should be used for working the Atlantic cable, or any other submerged conductor, with greatest speed. The limit to the rapidity of working must be determined by the conditions for carrying off the heat generated in the conduction by the passage of the electric current; and as the quantity of electricity which may be used on any cable without endangering the gutta percha insulation by the heat of the conductor can be ascertained only by experiment, it is by this means only, that the best size and number of plates can be determined for working with the greatest speed the cable will admit of.

In the passage of very large quantities of electricity into the cable the heating effect on the portion nearer to the battery will be considerable, for although the measure of the heating power of the current is the conduction resistance, and the resistance of the current is destroyed by the induction "*masking*" the electricity; yet as the portions of the cable nearer to the battery are first charged, and the conductor, after the dielectric is charged, resists as an ordinary conductor, it is evident that those portions will be heated by the current; yet the whole quantity of heat produced will be less than if no inductive action took place. Considering the whole quantity of heat generated by the oxydation of a given quantity of zinc, or the resistance to the electricity thereby generated, which is the same thing, and the greatness of the surface to carry off that heat, it is easy to foresee that a very large quantity* of electricity might be used on the

* While a quantity of electricity even *insufficient* to charge the whole cable might *rupture* it if in a state of very great tension, yet no danger of this need be apprehended from *any quantity* of electricity obtained from any easily attainable number of voltaic elements.

cable without endangering it, and consequently a high speed in transmission obtained. For a first trial on the Atlantic cable I would use a Smee battery of about 500 pairs of plates, each having 20 square feet of surface; yet it may be found on trial that plates of much larger size may be required.

Although the present cable may be incapable of working with a satisfactory degree of certainty and rapidity, even with the best electrical management, yet this would not demonstrate that there cannot be a satisfactory electrical communication across the Atlantic. Certainly I will be justified in saying that the present state of the engineering art and the experience already obtained in laying submarine conductors, can lay down a new cable capable of transmitting 100 letters per minute, if it is constructed and worked in full regard to the principles of electricity.

ART. XVIII.—*On the Variation of the Magnetic Needle at Hudson, Ohio;* by ELIAS LOOMIS, Professor of Mathematics and Natural Philosophy in the University of the City of New York.

DURING my residence at H[illegible] Ohio, between the years 1837 and 1844, I made repeate[illegible]rvations for the purpose of determining the variation of th[illegible]netic needle. During the summer of 1849, while employe[illegible]determining the longitude of Hudson by telegraphic comparisons with Philadelphia, I repeated my observations for the variation; and Prof. C. A. Young, of Western Reserve College, has put into my hands a very complete series of observations made by himself during the past summer. All these observations were made with a variation compass by Gambey of Paris, having a needle about 18 inches long, supported by fibres of untwisted silk, and resting in a stirrup which admits of easy reversal. It is now proposed to compare these observations for the purpose of determining the annual change of the variation. As these observations were made at different hours of the day, it is necessary to apply a correction to reduce each result to the mean variation of the month of observation. As the observations required for this purpose have never been made at Hudson, or at any place in its immediate vicinity, we must rely upon observations made at a considerable distance. The nearest station at which such observations have been made is Toronto, which is north of the parallel of Hudson. On the southern side we have observations both at Philadelphia and Washington. I have preferred the latter, since Washington is nearer to Hudson than Philadelphia; and the parallel of Hudson is exactly midway between the latitudes of Toronto and Washington.

The following table shows for six months of the year, the quantity by which the variation at the hour named in column first, differs from the mean variation for the month at Toronto. The table is derived from five years observations between 1843 and 1848, and is copied from page 90, vol. iii, of the Toronto observations.

Diurnal change of the Magnetic Variation at Toronto.

Hour.	April.	May.	June.	July.	August.	Sept.
8 A. M.	4′96 E.	5′82 E.	6′20 E.	6′26 E.	6′90 E.	4′80 E.
9 "	3·96 E.	4·18 E.	4·72 E.	4·86 E.	4·76 E.	3·00 E.
10 "	1·30 E.	0·64 E.	1·73 E.	1·78 E.	0·54 E.	0·56 E.
11 "	2·02 W.	3·06 W.	2·00 W.	1·76 W.	3·12 W.	3·70 W.
noon.	4·54 W.	5·24 W.	4·72 W.	4·24 W.	6·00 W.	6·26 W.
1 P. M.	5·98 W.	6·28 W.	6·20 W.	5·86 W.	7·22 W.	6·38 W.
2 "	5·84 W.	6·10 W.	6·26 W.	5·96 W.	6·52 W.	5·40 W.
3 "	4·98 W.	4·84 W.	5·26 W.	5·12 W.	5·04 W.	3·36 W.
4 "	3·30 W.	3·12 W.	3·76 W.	3·68 W.	2·74 W.	1·16 W.
5 "	1·66 W.	1·26 W.	1·68 W.	1·86 W.	1·02 W.	0·42 W.
6 "	0·80 W.	0·44 W.	0·62 W.	0·70 W.	0·18 W.	0·12 E.
7 "	0·32 W.	0·22 W.	0·28 W.	0·36 W.	0·13 W.	0·06 W.
8 "	0·44 E.	0·18 W.	0·32 W.	0·66 W.	0·10 W.	0·24 E.

The following table shows for the same months the quantity by which the variation at th[illegible]r named in column first, differs from the mean variation [illegible] month at Washington. It is derived from two years o[illegible]ions from 1840 to 1842, and is deduced from the table on [illegible]26 of Gilliss' Magnetical Observations.

Diurnal change of the Magnetic Variation at Washington.

Hour.	April.	May.	June.	July.	August.	Sept.
h m						
0 12 A. M.	0′97 E.	0′65 E.	0′67 E.	0′96 E.	0′82 E.	0′58 E.
2 12 "	1·81 E.	0·93 E.	0·39 E.	1·16 E.	0·99 E.	1·02 E.
4 12 "	2·42 E.	1·33 E.	1·27 E.	1·57 E.	1·26 E.	1·47 E.
6 12 "	2·75 E.	3·65 E.	4·09 E.	3·58 E.	4·03 E.	3·05 E.
8 12 "	3·21 E.	3·97 E.	4·72 E.	4·56 E.	5·30 E.	3·91 E.
10 12 "	1·04 E.	0·28 W.	0·19 E.	0·94 E.	0·59 W.	0·37 W.
0 12 P. M.	3·37 W.	3·80 W.	3·83 W.	3·86 W.	5·63 W.	4·84 W.
2 12 "	5·12 W.	4·60 W.	4·80 W.	5·31 W.	5·51 W.	4·52 W.
4 12 "	3·26 W.	2·45 W.	3·36 W.	3·41 W.	2·65 W.	1·51 W.
6 12 "	1·69 W.	0·48 W.	0·62 W.	1·19 W.	0·70 W.	0·54 W.
8 12 "	0·01 W.	0·64 E.	0·80 E.	1·01 W.	1·27 E.	1·22 E.
10 12 "	1·25 E.	0·45 E.	0·48 E.	1·03 E.	1·75 E.	0·54 E.

The following table shows the observations of the magnetic variation at Hudson. Column first shows the day of the month and year; column second the hour of observation; column third the observed variation; column fourth the correction applied to reduce the observation to the mean for the month; and column fifth shows the variation thus corrected. The correction is obtained by taking the mean of the numbers furnished by the Washington and Toronto observations.

Observations of the Magnetic Variation at Hudson.

Date.	Hour.	Variation observed.	Correction.	Variation corrected.
	h m	′	′	′
1839 April 15.	3 30 P. M.	51·96 E.	+4·02	55·98 E.
1840 April 13.	9 40 A. M.	53·87	−1·88	51·99
1841 May 18.	6 51 P. M.	48·80	+0·18	48·98
1842 May 12.	2 43 P. M	49·23	+4·60	53·83
" Sept. 20.	10 57 A. M.	43·35	+2·76	46·11
1843 June 17.	4 23 P. M.	38·87	+3·04	41·91
" Sept. 19.	8 2 A. M.	47·65	−4·29	43·36
1844 June 8.	4 1 P. M.	38·20	+3·61	41·81
1849 July 24.	5 14 P. M.	30·04	+1·93	31·97
1858 July 22.	11 40 A. M.	9·37	+3·03	12·40
" July 26.	6 12 P. M.	11·47	+0·91	12·38
" July 28.	4 1 P. M.	5·61	+3·59	9·20
" Aug. 4.	0 6 P. M.	9·30	+5·73	15·03
" Aug. 9.	6 10 P. M.	10·58	+0·43	11·01
" Aug. 16.	11 37 A. M.	4·25	+4·52	8·77
" Aug. 17.	5 55 P. M.	9·50	+0·61	10·11
" Sept. 1.	2 32 P. M.	9·52	+4·04	13·56

In order to deduce from these observations the most probable result, let us put δ for the mean variation Jan. 1, 1839, and Δ for the annual motion. Then if we regard the observations of any one year as forming a single observation, we shall have the following eight equations of condition.

$$
\begin{array}{ll}
\delta + 0{\cdot}285\,\Delta = 55'{\cdot}98 & \delta + 4{\cdot}586\,\Delta = 42'{\cdot}63 \\
\delta + 1{\cdot}279\,\Delta = 51{\cdot}99 & \delta + 5{\cdot}433\,\Delta = 41{\cdot}81 \\
\delta + 2{\cdot}375\,\Delta = 48{\cdot}98 & \delta + 10{\cdot}558\,\Delta = 31{\cdot}97 \\
\delta + 3{\cdot}538\,\Delta = 49{\cdot}97 & \delta + 19{\cdot}598\,\Delta = 11{\cdot}56
\end{array}
$$

Solving these equations by the method of least squares, we obtain $\delta = 55'{\cdot}213$, which is the mean value of the variation for Jan. 1, 1839; and $\Delta = -2'{\cdot}2416$; that is, the easterly variation is diminishing at the rate of $2\frac{1}{4}$ minutes in a year. We also conclude that the line of no variation will pass through Hudson sometime during the year 1863.

ART. XIX.—*On the Dynamics of Ocean Currents;* by Lieut. E. B. HUNT, Corps of Engineers, U. S. A.

(Read before the American Association, at the Baltimore Meeting, May, 1857.)

IT can scarcely be denied that the state of our knowledge of ocean currents is any thing but satisfactory. Not only are we to a very great extent ignorant of the precise state of the facts, but we are also deficient in the theoretical exposition of those already known. We can easily explain our lack of precise knowledge of facts by reference to the circumstances. The vast oceanic areas can be observed only by persons engaged in navigation, who are mostly unfurnished with proper means for correct determinations, and who lack that special training which is a prime

essential for good observations. The facts to be observed are also of a character so complex and elusive, are so subject to fluctuation in a given locality, and are involved in movements of air and water of so vast compass, that we cannot hope for precision of knowledge by the use of means now in operation. The single fact that most observations are made on the water surface while the ocean depths are of vital efficacy in shaping all marine phenomena, gives a character of signal incompleteness to those observations which have been mainly instrumental in fixing the received notions on the system of oceanic circulation. It is a fit subject of regret that the discussion of ocean movements has been so rarely attempted by those whose previous training in mathematical or mechanical science would have been a sufficient guaranty and preventive against the wild and illogical rhapsodies of theorists who have run riot over the broad domain of the physics of the sea.

With a view to apprehending the mechanical elements of this problem of ocean currents, let us first suppose a terrestrial sphere, which has assumed the equilibrium condition, resulting from gravitation, diurnal rotation, a solid nucleus and a homogeneous water envelope unbroken by land. This water stratum would shape itself so that its bounding surface would be a strictly mathematical level surface. A level surface of this nature may be defined as one which is at each point perpendicular to the resultant of all the forces acting on the individual molecules situated in that surface. In this case it would be a continuous oblate spheroid to which the resultant of gravity and centrifugal force would be everywhere normal. If to this we add those diurnal disturbances of the normal level due to the irregularities of solar and lunar attraction during the earth's rotation, we obtain the tidal waves which appear as perturbations of the normal level. If the continental masses be supposed to be elevated, we have a slightly modified normal level surface for the ocean; but one, which once determined becomes the proper standard of reference for all oceanic perturbations, to whatever cause due. This surface is everywhere the true bounding surface, and cuts the resultant of gravity and centrifugal action for the earth *as it is*, perpendicularly at each point of the surface, and is entirely continuous, though no more truly spheroidal. This is the normal ocean level, and it is a useful surface of reference for all vertical ocean movements or perturbations. If we now suppose the homogeneous earth without continents subjected to the heating action of the sun's rays, the result will be that the equator will become a line of maximum heating, from which to the poles there will be a progressive diminution of heat absorption. This would cause an expansion of the heated waters which would thus rise above the normal level surface by an amount equal to

the expansion at each point. Thus from the pole to the equator a spheroidal meniscus would be spread equal to the ocean expansion under the solar heat. It is a remarkable feature that the heating leaves each vertical ocean column of its original weight, and there is thus a perfect mechanical equilibrium between these columns considered as joined by their interior bases. Thus considering the grand ocean masses, there is no disturbance of static stability from the heating agency of the sun, hence there is no formation of massive currents due to this cause.

If now we regard the heated ocean in its hydrodynamic aspect, we find that the bounding surface having everywhere a slope toward the pole exceeding that of the normal level surface, there remains an unresisted surface tendency towards the pole which primarily tends to produce a superficial flow from the equator polewards. This gives manifestly but a slight disturbance of normal level, amounting in the meridian quadrant only to the vertical expansion at the equator, and being diffused over the entire quadrant. It is extremely doubtful if this would suffice to overcome the passive resistances and produce an actual surface overflow. If, however, a current were once established by any other agency, such as the wind, the equatorial heating would constantly operate to maintain this current. The heated waters would constantly be lifted as a floating mass on the colder waters which, pushing on the lighter equatorial mass at its base, would come in to replace any deficiency of mass due to the superficial outflow. Taking the facts as they are, we find in the trade-winds and the resistance of the continents, two causes fully adequate to break up the static equilibrium referred to, and obviously giving the precise direction to the outflow which it actually has. Thus while the type of action induced by the solar heating power considered along the meridian is surface outflow and deep inflow, the perennial trades determine this circulation along a different and constant route, fixed first by continental obstructions, and essentially modified in direction by the earth's rotation.

As the equatorial evaporation greatly exceeds the corresponding rain fall, this operates to counteract in part the regular outflow by diminishing the quantity of water to be discharged on account of expansion due to heating. This would also increase the saltness and specific gravity of the equatorial waters, and to that extent would bring their actual surface into close accordance with the normal level. It is clear that this saltness could not fully compensate for the expansion by heating, or we should have the surface reduced to the normal level, when all would either be in stable equilibrium, or below it when the currents would be reversed.

It thus appears that the expansion due to equatorial heats induces a superficial derangement tending to an outflow towards

the poles, which by the trade winds and continents is determined along a single line of *debouche*. This gives a discharge with far less frictional resistance than a direct meridional outflow would encounter, as this would involve a polar set for the entire ocean surface.

Accepting the well-determined trade-winds and the equatorial current as certain facts, we shall find that the vast surface sheet of water which has a westerly set under the trades, having acquired a very considerable velocity, becomes the representative of a vast amount of living force. When by impact against western barriers this vast sheet of water undergoes inflection to the north or south, it still retains the greater portion of its living force, and will continue to do so until this is wholly expended in overcoming resistances. If now we bear in mind that the wide equatorial sheet is by this deflection consolidated into a compact current of deep section, and also that the resistance per mile is proportionate to the length of the line of frictional resistance in a cross section, we shall see that the currents turn towards the poles with their forward impulse almost unabated, and with the resistances greatly reduced. We ought, therefore, to expect that the inertia of this vast moving mass would suffice to carry it on with a mean velocity, slowly abating, to the polar regions. So soon as the progress of the current gives it an increasing latitude, the effect of the diminishing parallels in giving an eastward trend would show itself; and, combined with the forward projectile motion of the mass of waters, would determine the route of the current, governed, of course, by solid opposing masses of continents, islands, and shoals.

Reaching the artic neighborhood, this current would fall in with the tendency to restore to the equatorial region the waters withdrawn by outflow, which thus leave a deficiency of static mass in that region. Its forward force not yet expended, would bring it into the equatorial flow only after a long arctic sweep. Then bordered in by the eastern ocean coasts, it circles on to the equatorial belt, there to start the repetition of its course either directly, or by proxy, if, entering at great depths, it serve only to lift higher portions above the normal level. We have thus a continuous circuit in which the water whirls under the primary impulse derived in the equatorial regions, an outflow due to heating and the direct propulsion of the trade-winds. The primary order of circulation is in two currents, the upper running polewards, and the under from the poles to the equator. This order is entirely modified by the action of the trades, and becomes essentially a horizontal circulation, the propelling action of these perennial winds, conspiring with the outflowing declivity to determine an immense movement, of which the living force imparted in the equatorial region suffices to carry on the circuit in full and enduring activity.

This consideration of the effect of inertia in storing the living force of this immense equatorial current, and thus enabling it to sweep through the cycles of the seas, has not been duly considered. These currents, in such a place as Florida Straits, move in a closed channel, and are subject to the hydrodynamic rules for this case. The gradual changes of direction and velocity there imposed, produce less absolute resistance than is generally imagined, by reason of the great mass of waters relative to the area of frictional surfaces.

The problem of ocean currents is of very great complexity, not only on account of the difficult hydrodynamic questions involved, but because the effect of the winds on the ocean surface can scarcely be subjected to estimation. The permanent elevation of the equatorial waters above the normal level traced from the pole, might be approximately determined by knowing the mean equatorial ocean temperature at all depths, and the same from point to point towards the poles, accompanied with observations on the corresponding saltness. Were there a considerable deficiency of weight in the vertical equatorial column, relative to an arctic one, connected by their bases at the same deep level, this would at once generate a corresponding wave towards the equator. As we may be sure that the equatorial mean ocean temperature exceeds the artic mean temperature, we must concede *some* elevation above the true normal level throughout all the warmer latitudes, but any attempt to definitely fix its amount, would be very rash in the present state of our knowledge.

There are numerous secondary points which might enter this discussion, but which need not now be considered. I will notice a slight oceanic oscillation which is practically unimportant; but which I believe has not before been noticed. The sun in its daily round must heat the waters of the sea, at a given locality, in such a manner that there shall be a daily maximum and minimum sea temperature due to absorption and radiation combined. This must give a maximum and minimum of expansion, or a species of tidal wave would follow the sun, which might well be called the heliothermal tide. It would clearly be too minute for separate observation, and though curious, cannot be important.

Another circumstance is worth notice here. A forward current in the sea has a distinct bounding surface on which it encounters a frictional resistance. The mode in which this resistance is expended is by a constant dragging into the forward movement parts of the layer of water making the boundary of the current. Thus if a current be moving through a sea otherwise tranquil, it will by this lateral dragging carry forward such a volume of water in addition to its own proper mass, that a counter-current must set in to restore the level. This is, I sup-

pose, the explanation of some of the counter currents which exist along the great oceanic currents, as also of the eddy currents of rivers. These too imperfect generalizations may do something towards making the system of ocean currents more comprehensible. So great a subject needs treatment far different from what it has yet received, and first of all the essential facts should be more clearly established. Unfortunately this can result only from long, well organized, and costly operations for this express purpose. We must be content to do our several small parts patiently, hoping for more light in the future.

ART. XX.—*Report on Dupont's Artesian Well at Louisville, Ky.;* by J. LAWRENCE SMITH, M.D., Prof. Chem. University of Louisville.

THIS work was commenced in April, 1857, from the bottom of a well that had a depth of 20 feet, the boring tools employed made a hole 5 inches in diameter to the depth of 76 feet from the surface; the boring was now reduced to 3 inches, and thus continued to the bottom of the well. The depth of well is 2086 feet; flow of water 330,000 gallons in 24 hours; rise above the surface 170 feet.

The rock struck, which geologically belongs to the Devonian series, is for 38 feet shell limestone; then for 40 feet coralline limestone; at which depth the Upper Silurian is reached. Without being able to make out with any degree of certainty, the amount of Upper Silurian passed through, we suppose it to be over 1200 feet. At the depth of 1600 feet a sandstone was reached, doubtless of the Lower Silurian, and 97 feet deeper was encountered the first stream of water which reached the surface. This flowed out abundantly and with much force. The quantity not being sufficient, the boring was continued. After this, it was unnecessary to use the bucket to take out the material detached by the borer, the force of the water bringing up the fragments very readily. The water increased in quantity in going deeper, the increase being more marked at 1879 feet, and still more at 1900 feet, where pieces of rock weighing an ounce or two came up with the water. The water increased every ten or twenty feet to the depth of 2036 feet; here a very hard magnesian limestone was encountered 6 feet in thickness. After which the sandstone reappeared, and for the next 50 feet there was no increase of water.

The following table exhibits the series of rock as far as it is possible to make it out by the fine fragments taken out at different depths, beginning at the top:

76 feet, sand and gravel.
100 feet, tolerably pure limestone, with fragments of fossils.
12 feet, soft limestone mixed with clay.
52 feet, tolerably pure limestone mixed with fossils.
5 feet, limestone with ferruginous clay.
81 feet, gray limestone.
157 feet, limestone mixed with clay.
149 feet, tolerably pure limestone with many portions quite white.
13 feet, clay shale with little calcareous matter.
207 feet, limestone with a little blue clay shale.
33 feet, same, little darker and more shale.
Next 94 feet, pure, very white limestone with fossil alternating with very dark limestone, color probably from organic matter, with some dark shale.
26 feet, shaly limestone.
40 feet, very light and hard pure limestone.
1 foot, white clay.
546 feet, gray limestone, alternating hard and soft.
41 feet, sand rock—white.
4 feet, same, very fine and hard, with little limestone.
60 feet, same, with more lime.
72 feet, same, less limestone.
308 feet, same sandstone with but little lime.
6 feet, magnesian limestone, very hard.
50 feet, sandstone again.

At the urgent request of many citizens of Louisville, the boring was now stopped to give a fair test of the medical virtues of the water that was pouring forth at the rate of 230 gallons per minute, or about 330,000 gallons in 24 hours. The water, by its own pressure, rises in pipes 170 feet above the surface.

The boring was accomplished in sixteen months, and the depth reached is 2,086 feet. In order to conduct the water to the surface and prevent its passing off into the gravel beds below, a tube five inches in diameter leads from the surface to the rock, a depth of seventy-six feet, into which it is driven with a collar of vulcanized gum elastic around it. No tubing is found necessary for any other part of the boring.

When the size of the bore (three inches in diameter) and its depth are considered, the flow of water from the well is unequalled by any other artesian well yet constructed that flows above the surface, for, although the Grenelle well at Paris delivers 600,000 gallons in twenty-four hours, it has at the bottom an area six times as great as the Dupont well, and a few hundred feet up seven times as great. A corresponding diameter to Dupont's well would, according to just and reasonable calculations, furnish about 2,000,000 gallons in twenty-four hours; also the elevation of the water above the surface is greater than that of any other artesian well, and it is only exceeded in depth by the St. Louis well, and that to an extent of 113 feet.

The water comes out with considerable force from the five-inch opening, and a heavy body thrown into the mouth of the well is rejected almost as readily as a piece of pine wood. By an approximate calculation, its mechanical force is equal to that of a steam engine with cylinder 10 by 18 inches, under 50 lbs. pressure, with a speed of 55 revolutions per minnte, a force rated at about 10 horse power. The top of the well is now closed, and the water conducted about 30 feet to a basin with a large jet d'eau on the centre, from which there is a central jet of water 40 feet in height, with a large water pipe, from which the water passes in the form of a sheaf. When the whole force of water is allowed to expend itself on the central jet, it is projected to the height of from 90 to 100 feet, settling down to a steady flow of a stream 60 feet high.

Temperature of the Water.—The water, as it flows from the top of the well has a constant temperature of 76½° F., and is not affected either by the heat of summer or the cold of winter. The temperature at the bottom of the well is several degrees higher than this, as ascertained by sinking a Walferdin's registering thermometer to the bottom, which indicated 82½° F. Taking as correct data that the point of constant temperature below the surface of Louisville is the same as at Paris, namely, 53° F., at 90 feet below the surface, we have an increase of 1° of temperature for every 67 feet below that point. The increase in Paris is 1° for every $61\frac{2}{10}$th feet. The temperature of the water is sufficient for comfortable bathing during most of the year, a circumstance that will be of considerable importance, if it ever be turned to the use of baths. The reason of the difference of 6° between the water at the bottom of the well and at the top is, that the iron pipe leading from the surface to the rock passes through a stratum of water 60 feet thick, having a temperature of 57°.

The Source of the Water.—The question naturally arises, if the vein of water supplying this well has a connection with some distant source higher than the surface of Louisville, where is that source? From all that we have been able to learn of the geology of this county, taking Louisville as a center, the first rocks encountered corresponding to the sandstone (in which the water of the artesian well was struck) are in Mercer, Jessamine, and Garrard counties, near Dix Creek, to the east of Harrodsburg. The rocks there are said to be cavernous and water-bearing. The elevation is about 500 feet greater than Louisville, and about 75 miles in a straight line from this city.

This being the most probable source of the water, from whence come its mineral constituents? These are obtained from the rocks through which it percolates in its way from its source to the point below Louisville, where it has been tapped, and where

it will doubtless flow in undiminished quantity for centuries to come, as wells having such deep sources as this, are usually inexhaustible.

Nature of the Water.—The water is perfectly limpid, with a temperature as already stated of 76½°, which will be invariable all the year round.

Its specific gravity is 1·0113. The solid contents left on evaporating one *wine gallon* to dryness are 915½ grains, furnishing on analysis:

	Grains.
Chlorid of Sodium, (common salt,)	621·5204
" Calcium,	65·7287
" Magnesium,	14·7757
" Potassium,	4·2216
" Aluminum,	1·2119
" Lithium,	0·1012
Sulphate of Soda,	72·2957
" Lime,	29·4342
" Magnesia,	77·3382
" Alumina,	1·8012
" Potash,	3·2248
Bicarbonate of Soda,	2·7264
" Lime,	5·9915
" Magnesia,	2·7558
" Iron,	0·3518
Phosphate of Soda,	1·5415
Iodid of Magnesium,	0·3547
Bromid of Magnesium,	0·4659
Silica,	0·8857
Organic Matter,	0·7082
Loss in analysis,	8·1231
	915·4582

GASES IN ONE GALLON.

Sulphuretted Hydrogen,	2·0050
Carbonic Acid,	6·1720
Nitrogen,	1·3580

The analysis was performed by the usual methods; but as chlorid of lithium was sought for and found, it may be of interest to detail the method of research in this particular, as a guide to similar investigations of other mineral waters in this country. Ten gallons of water were evaporated to about two pints, (there was an abundant deposition of salts,) to this was added one gallon of 95 per ct. alcohol; it was then thrown on a filter, and the salts on the filter washed with alcohol of the same strength—the filtered liquid was evaporated nearly to dryness; in the present instance the residue consisted of a few ounces of a thick syrupy liquid; to this was added one pint of absolute alcohol, addi-

tional salts were precipitated; the liquid was again filtered and evaporated nearly to dryness—to it were added 8 oz. distilled water and two ounces of milk of lime, (pure lime made by igniting carbonate of lime prepared by carbonate of ammonia,) the lime was added for the purpose of precipitating the magnesia and alumina—again filtered and washed; the filtered liquid was somewhat concentrated, and while warm, carbonate of ammonia added to precipitate the lime; it was then filtered and evaporated to about a fluid ounce and treated with a little lime water and carbonate of ammonia alternately, to insure the absence of the last traces of magnesia and lime.

Before going further, it would be well to state that the treatment of alcohol separates the great mass of salts that are held in solution by the water, and which interfere with the detection of so minute a constituent as the lithium salt—by the alcohol we reduce the salts to small amounts of chlorids of magnesium, aluminum, calcium, sodium, potassium and lithium; by the lime the first two are got rid of, and by the carbonate of ammonia the lime is precipitated.

The solution, now containing the chlorids of sodium, potassium, lithium and ammonium, is evaporated to dryness, and the residue heated to dull redness, by which the ammonia salt is expelled and a little organic matter destroyed; the residue is next dissolved in water, and a drop or two of the liquid tested for a sulphate; should this be present it must be got rid of by exact neutralization with chlorid of barium, (a slight excess of the chlorid of barium will not interfere with the other steps in the analysis); in the examination of the water in question no trace of sulphate was found at this stage of the process, so it was again evaporated to dryness in a small capsule over a water bath; there were now a few grains of residual matter. To this was added an ounce of a mixture of equal parts of pure ether and absolute alcohol, the capsule was covered with a small receiver and allowed to stand for 18 hours; the liquid was then thrown on a small filter, and the filter washed with a little of the mixture of ether and alcohol. The alcoholic ether solution evaporated to dryness furnished the chlorid of lithium recognized by its well known characteristics. Although this process requires considerable time and some careful manipulation, its results are both accurate and satisfactory.

The water of this artesian well has very valuable medical properties, and those readers who are curious to examine into these points, will obtain all the required information by sending to Louisville for the medical report.

ART. XXI.—*On Modes of increasing the Heat of the Mouth Blowpipe, and some new Blowpipe Manipulations;* by Prof. HENRY WURTZ, of the National Medical College, Washington, D. C.

[Read, with experimental illustrations, before the American Association for the Advancement of Science, at Baltimore, April, 1858.]

IN the course of some blowpipe investigations which I have in progress, it has been found extremely difficult, and sometimes impossible, to obtain in the ordinary way sufficient heat for the production of certain desired effects. Attempts were therefore made to devise means of increasing the heating power of the instrument, and this object has been so far attained, and by means so simple and efficient, that I take this opportunity to make these means public, that others may also be benefitted thereby. To blowpipe analysts it is not necessary for me to detail the advantages to be gained in many cases by a practicable mode of increasing the heat, of which advantages not the least important is the saving of time.

It was first observed that in the ordinary mode of manipulation, a great part of the heat was conducted away from the bead by the cold part of the platinum wire contiguous to it. This is easily prevented by simply bending the wire previously, at right angles about an inch or an inch and a half from the loop that is to hold the bead.* On then holding the bead at the point of the blue cone of the flame, and the wire so that the bent portion is coincident with a continuation of the axial line of the flame, this bent portion becomes also heated to high redness, losing thus in a great degree its tendency to abstract heat from the bead. By this little contrivance alone the heat is increased to so important a degree, that I venture to think that no one who has once tried it, will ever use a wire of any other form.

I next directed my attention to the *combustible* used. An ordinary alcohol flame, as every one knows, gives with the blowpipe a comparatively feeble heat. A gas flame is much superior, and a large *wax candle* gives probably a higher heat than any thing else at present commonly in use among blowpipe operators. It occurred to me that the heating effect was probably proportional to the *density* of the burning vapor, or the quantity of

* At the time the above was read, I had no suspicion that the contrivance of bending the wire had ever been published before, or thought of, by any other than myself. Since, however, Prof. Brush of New Haven has directed my attention to a passage in the last edition (1853) of Plattner's "Probirkunst mit dem Löthrohre," page 14, where the same device is identically described, as used for fusing platinum wire. I desire, therefore, stating at the same time that I have been in the habit of using it for more than ten years, to disavow all claim to priority, hoping still that some novelty may be found in my modes of making use of the invention.—H. W.

combustible matter contained in the same volume. I therefore searched for combustibles having a high density of vapor, and found that the *paraffine* of Reichenbach, now known from the investigations of Hofstaedter* and Filipuzzi† to be a mixture of different isomeric hydrocarbons, all of which must have very high equivalents, was found by Lewy‡ to have a vapor-density of not less than 11·8. By inquiry, I found that candles composed of this, or a similar material, obtained from the products of distillation of the well-known "Breckenridge Coal," could be bought in New York. On procuring some of these, and using them as *pabulum* for the blowpipe-jet, I found my anticipations fully realized. The flame obtained by means of the paraffine candle is much hotter than that from a wax candle. Unfortunately the candles made in New York are small, and have *extremely* small wicks, which renders them difficult to manipulate with, because the least motion of the jet-piece, by throwing it out of the centre of the flame, deranges the form of the cone. This can of course be easily remedied by having larger candles made with larger wicks.

Next, and lastly, *the blowpipe itself* seemed to me susceptible of improvement, by the introduction of an agent to absorb the moisture and carbonic acid of the breath, which must necessarily diminish the heating power of the flame. I have therefore sought to eliminate these obstacles by using, instead of the tube of the ordinary blowpipe, a somewhat larger tube filled with fragments of caustic potash. In the instrument which I have heretofore used, and which I now exhibit, this tube is composed of glass, and is united with the jet-piece of an ordinary blowpipe of Berzelius' form by means of a perforated cork; but of course in practice this tube may as well be composed of metal to avoid breakage. I use the ordinary *potassa fusa*, occurring in the shops in the form of sticks, broken up to about the size of a split pea, the fragments being confined in the tube by a plug of cotton at each end. It is advisable, when this kind of blowpipe is not in use, to keep the upper end of the tube corked. It remains yet to be seen whether the additional advantage gained by using a blowpipe of this construction will compensate for the concomitant inconveniences, though the latter are far less important, according to my own experience, than many would suppose.

Now as to the effects which may be produced by the combination of these several appliances. Platinum wire of medium blowpipe size is fused with little difficulty, and I have obtained beads of considerable diameter. Fine platinum wire melts down

* Liebig and Kopp's Jahresbericht, 1854, 608.
† Ibid. 1855, 630.
‡ Loewig's Chemie der organischen Verbindungen, ii. 564.

like wax. A borax bead volatilizes rapidly in white smoke. By moistening the end of a bent platinum wire, and dipping it into pure carbonate of lime or pure magnesia, and exposing it to the flame, a very fair exhibition of Hare's lime light, in miniature, may be made. The fusion of a small iron wire, and the combustion with brilliant scintillations of a small steel watch spring may be exhibited as class experiments in a very striking manner.

Berzelius, in his work on the Blowpipe,* says, "I am convinced that the temperature produced by the blowpipe, fed by air from the lungs, has a distinctly defined limit; so that, for instance, *alumina* or *silica* cannot be melted, however small fragments of them be employed." Now although I have not yet succeeded in producing large globules of fused silica, yet any person, by adopting the above expedients, may convince himself that the degree of heat thus obtainable is adequate for the fusion of silica. My experiments were made with chemically pure precipitated silica, and with a fragment of a colorless transparent crystal of quartz, from Herkimer county, New York, finely pulverized in an agate mortar. By taking a small platinum wire, bent as above, first fusing the end into a globule, then moistening this globule with saliva, or better (in order to avoid the introduction of any trace of *basic* contamination, which might be supposed to form a fusible silicate), with *syrup* made from pure sugar, and dipping it into the powder, then gently heating and incinerating in the flame of a spirit lamp, the silica powder remains loosely attached to the wire, and under the lens appears now perfectly impalpable and devoid of transparency. If now the potash-tube blowpipe, with paraffine candle flame, be brought to bear upon it for a minute, the silica being held a little way *outside* of the point of the blue cone, which in this kind of flame appears to be the hottest point, it will then be found strongly adherent to the wire, as if melted fast, and under the lens presents the appearance of small, transparent, irregularly shaped globules, *fused fast* to the platinum. I have little doubt that with a large paraffine candle, and larger jet, a *splinter of quartz* might be fused.†

The above mode of obtaining a high heat is essential to the practicability of a peculiar mode of manipulation that I have devised, and which I shall proceed to describe.

* Whitney's Translation, page 46.

† Berzelius, in a note, mentions an announcement of H. de Saussure that he melted *quartz*, supported on a slip of *kyanite*, with a jet of air from a *double bellows* through the flame of a thick *wax candle;* adding, however, that he suspects that "the support may have produced an effect on the assay, and that the air from the bellows, being purer than that of the lungs, may have also contributed to effect a result which cannot be obtained by the mouth blowpipe."—*Whitney's Translation*, p. 54.

Many minerals and artificial products, when dissolved in a borax bead *in large quantity*, cause the bead to become opaque and milky on cooling, forming in fact an *enamel*, instead of a glass. Some of these are *lime*, *magnesia*, *baryta*, *strontia*, *glucina*, *oxyds of zinc*, *cadmium* and *cerium*, *tungstic* and *titanic acids*, *calcite*, *magnesite*, *dolomite*, *witherite*, *baryto-calcite*, *strontianite*, *gypsum*, *epsomite*, *heavy spar*, *celestine*, *goslarite*, *smithsonite*, *fluor spar*, *apatite*, *sphene*, *aeschynite*, *polymignyte*, *yttro-tantalite*, *scheelite*, *scheeletine*, *xenotime*, *yttro-cerite*, *fluocerite*, *cryolite*, &c. A great many more render the bead of *microcosmic salt* opaque or opalescent on cooling, and as some reactions, for instance that of *titanic acid*, are much more easily obtained in this than in the borax bead, these cases are also frequently of importance.

Now when it is desired to detect another substance occurring in small quantity in any of the above, such for instance as *manganese*, *copper*, *cobalt*, or *titanium*, by the color imparted to the bead after cooling, it is frequently impossible to do so, for the reason that if enough is added to give a decided reaction, the bead becomes opaque on cooling and the color cannot be seen.* In considering the cause of this loss of transparency, it seemed to me that it must be a granular *crystallization*, and remembering the fact that even *common glass*, if made to cool very slowly from fusion, becomes opaque and enamel-like, with many other familiar facts of an allied nature, it occurred to me that the converse of this phenomenon might also take place, or that an enamel which becomes transparent and vitreous when fused might retain its transparency when *suddenly* cooled. I was thus led to dip a bead composed of a highly basic borate of lime enamel into cold water while still fused. The result verified the hypothesis. The bead when cooled in this way remained transparent, and manganese was thus distinctly detected in a purely white marble, in which its presence could be distinctly pronounced upon otherwise only by Crum's test.

For a number of years I have had constant occasion to use this expedient, and have found it a highly valuable one. Blowpipe operators will need no further remarks upon the importance of such an addition to our facilities for investigation. It is necessary, however, that careful examination be made of all special cases, a work of time and patience, which I hope, nevertheless, soon to take up systematically.

As before intimated, it is necessary, or at least highly conducive, to the success of this new manipulation, to have means, such as are above detailed, of obtaining an increased heat; be-

* Speaking of *red zinc ore*, Berzelius says that it is dissolved by phosphorus salt, but that "the color of oxyd of manganese cannot be obtained till the glass has dissolved so large a quantity that it is no longer transparent on cooling."—*Whitney's Translation*, page 116.

cause these supersaturated beads, which *enamelize* (if I may be allowed to coin a new but convenient word) on spontaneous cooling, require a much higher temperature for fusion than those which remain vitreous, and without some additional facilities for obtaining this higher heat, the tax upon the time and patience of the analyst becomes very onerous, and in many cases I have found it in fact *impossible* to succeed by the ordinary mode, for when the bead is very highly basic, it must be heated considerably *above* its point of fusion, or it solidifies to an enamel immediately on removal from the flame. It was this necessity which led me to devise the above modes of increasing the heat. It is by no means necessary, however, in ordinary cases, to use *all* of the expedients described. In fact, for the fusion of most of these borax enamels, the *bent wire* alone, with an ordinary blowpipe and an alcohol or gas flame, will suffice, and most others need only the additional assistance of the paraffine candle.

Whilst upon this subject of the blowpipe, I may be pardoned for offering briefly another suggestion. While making the experiments upon the reciprocal neutralization of the colors of metallic solutions, described in a former paper,* it struck me that the same principle should have applications in blowpipe analysis. It *must be* that when several metallic oxyds are present in a glass their several colors must interfere with each other in certain ways, and if we knew how to eliminate one or more of these colors by adding a neutralizing ingredient, so as to render others apparent, might it not furnish us with new facilities for research, and enable us to avoid old sources of error? I may conclude by noticing two or three results, which I have obtained, bearing upon this question. A deep amethystine bead of manganese glass acquired, on addition of a little oxyd of chrome, a *gray* color, resembling that produced by a mixture of solutions of chlorid of cobalt and chlorid of chromium, without any tinge of either red or green; a trifling additional quantity of oxyd of chrome giving, however, a distinct green color.† Another manganese bead gave a similar gray color on addition of oxyd of copper, but a slight excess of the latter imparted then a *blueish* tinge, which might easily be attributed to a trace of *cobalt.* The presence of nickel does not affect the blue color of a cobalt glass, as it does the rose color of cobalt in aqueous solutions, unless its quantity, compared with that of cobalt, is very great.

* Am. J. Science [2], xxvi, 49.

† In the decoloration of *ferriferous glass* by the addition of deutoxyd of manganese, "glass-makers' soap," is the action *wholly* due to the conversion of the ferrous into ferric oxyd, or *partly* also to the neutralization of a portion of the green ferrous color by some violet manganese glass formed?

ART. XXII.—*On the Pendulum;* by F. A. P. BARNARD, President of the University of Mississippi,—*with a description of an Electric Clock*, constructed by E. S. RITCHIE, of Boston, for the University of Mississippi, under the direction of President Barnard.—With a Plate.

[From the Proceedings of the American Association at Baltimore, 1858.]

THE importance of the pendulum as an instrument for the measurement of time, is sufficient to justify any amount of effort which may be made to secure the regularity of its performance. The causes which disturb this regularity exist partly in the nature of things, and are partly introduced by the contrivances employed to maintain the motion of the instrument. Among these, the effect of varying temperature in altering the distance between the centre of oscillation and the point of suspension, is one which has given occasion to many ingenious inventions; yet, however effectual some of these may have been in removing the irregularity due to this cause, it is probably true that no plan of compensation has been found in practice to be entirely satisfactory. It is an opinion entertained by the writer, though it is proposed with some diffidence, that the problem of compensation cannot be experimentally studied with results to be perfectly relied upon, so long as the pendulum has any *work to do;* and this must be the case whenever the maintaining power is derived, directly or indirectly, from a train of wheel-work. The different forms of anchor or pallet escapement involve friction upon the pallets, which, however nearly constant it may be, cannot be wholly so, and however slight it may be, either absolutely or in its variations, cannot be altogether insensible as a disturbing cause. For small as may be the amount of fluctuation in this resistance, it is to be considered that all the quantities concerned in the question of maintaining the motion of the pendulum are small, and that every minute variation is multiplied thousands of times. But a more serious cause of irregularity in the pendulum directly driven by a train, is to be looked for in the varying condition of the train itself, and of its lubricants; in consequence of which the power of the prime mover is to some extent absorbed, and is at different times unequally communicated to the pendulum.

When we attempt to study, in the actual performance of the pendulum, the efficacy of any plan of compensating the effects of temperature, it is impossible entirely to distinguish the irregularities due to one cause from those which may proceed from another. Cold, for instance, by stiffening the lubricants may cause the clock to gain, and this effect may be erroneously ascribed to an under-compensation of the contraction of the

pendulum-rod. And though, in such a case, if the clock should run more slowly than in warmer weather, we might justly infer an over-compensation to exist, we should be unable to determine exactly the excess.

The partial or total failure in practice of plans of compensation theoretically perfect, has been sometimes attributed to the unequal rapidity with which changes of temperature take place in different parts of the same pendulum. Every plan of compensation is necessarily founded on the supposition that, under all alterations of temperature, the temperature throughout the entire instrument is simultaneously the same. It is easy to see, for example, that if the mercury employed to compensate the pendulum of a common astronomical clock were to be wholly inclosed in a cylinder of some material entirely impervious to heat (supposing such a material to exist), it would be altogether useless for the purpose intended. And that which would thus be true, on the supposition that the mercury could not change its temperature at all, must be measurably so, if its changes of temperature lag behind those of the rod. Glass jars for containing the mercury in pendulums of this construction have been objected to, on the ground that they do introduce an irregularity of this sort; and accordingly Mr. Dent, the distinguished practical horologist of London, introduced in place of them cylinders of iron. The objection has been founded, I believe, rather upon the observed performance of the pendulums, than upon actual observation of the relative temperatures of the mercury and the rod. It would seem not to be difficult to arrange a pendulum with thermometers which should show constantly the true temperature both of the mercury and of the rod. And considering the importance of the question involved, such an experiment would appear to be well worth making, before pronouncing the mercurial compensation to be unsatisfactory, or even condemning the glass cylinders.

The escapements called remontoirs apparently set the pendulum free from most of the liabilities to disturbance which the train introduces. In clocks provided with these escapements, the force of the train itself is exerted not in impelling the pendulum, but in raising a small weight, or bending a slight spring, which subsequently acts—the former in its descent or the latter in its recoil—in moving the pendulum. The gravity-remontoir apparently furnishes an impelling force which is perfectly uniform, there being nothing but the very slight friction on the pivots of the arms carrying the remontoir weights to disturb this uniformity. The spring-remontoir is free from even this source of disturbance, but is open to a more serious objection, in consequence of the varying elasticity of the spring occasioned by change of temperature. Both of these contrivances, however,

impose a certain duty on the pendulum, which is, to unlock the train at the moments when it is necessary that the remontoir motor should be raised. This cannot be done without friction, although the friction is less than in the case of pallet escapements. It is also true that, in proportion as the friction required to unlock is reduced, these escapements become liable to the accident of failing to lock—or of *tripping,* as it is technically called —whereby error is introduced into the time shown upon the dial.

Of all these escapements, remontoir escapements and pallet escapements alike, it may finally be said that they require the pendulum to swing through a certain arc larger than would be necessary if the maintaining power could be applied to it from without, leaving it subject to no disturbances whatever, beyond those occasioned by the varying temperature and density of the air. The usual extent of the arc of vibration is 2° on each side of the vertical. About one quarter of this distance is required merely to unlock the train of the remontoir. If now, at a definite point of the swing, a light weight could be deposited upon an arm projecting from the pendulum rod, allowed to remain there during the descent, and then removed, and if this could be repeated on one side and on the other alternately, with perfect regularity and at precisely the same distance always from the centre of motion, and if this could be done without any friction or concussion, we should have a pendulum subject to no forces accelerating or retarding but such as may be accurately estimated in their amount, and in their effects upon the time of vibration.

I do not overlook the fact, that the manner of suspending the pendulum may have some influence on its performance. But as the suspension is almost invariably by means of a very flexible but also very elastic spring, the effect due to the resistance of this spring in the ascent may be considered as neutralized, so far as regularity of vibration is concerned, by its recoil in the descent; and for the variations of its elasticity with change of temperature, a special compensation may be made.

The problem which is here proposed, seems to present a condition difficult to be fulfilled. The impulse is to come at the proper moment, but the pendulum is to do no work in order to induce it. Yet it can be nothing but the pendulum itself which is to determine the moment of application; since if we possessed any independent mechanism sufficiently regular to do this, we should have no need of the pendulum. It is believed that the difficulty which this consideration presents has been overcome.

The clock which is herewith presented for the examination of the Association is one in which electricity is made to work a remontoir apparatus, by which very slight weights are made to impel the pendulum, alternately, on either side. There is nothing new in the idea of an electric clock; but there is something

sufficiently novel in a clock in which the pendulum does absolutely no work at all (not even in making battery connections), to deserve attention. There have probably been as many varieties of electric clocks as of escapement clocks—conceived, at least, if not constructed. All of these known to the writer, involve as much friction as the dead-beat escapement—most of them a great deal more—or else are otherwise objectionable. That which seems to be least so, is a contrivance described in the third volume of Becquerel's Electricity, and attributed to Mr. Vérité, in which two light balls are suspended by metallic threads to a horizontal lever oscillating on pivots placed just above the point of suspension of the pendulum. Two arms from the pendulum alternately touch these balls, closing a battery circuit by the contact. The corresponding end of the oscillating lever is thereupon depressed, relaxing the suspending thread, so that the ball presses upon the pendulum arm until the latter is carried by the swing out of its reach; when, the circuit being broken, the lever rights itself again. Ingenious as this arrangement is, the objections to it are too obvious to require enumeration. It furnishes a force which fails in the three essential requisites,—perfect uniformity in quantity, uniformity in duration, and uniformity in the point of application. The suspending thread, however flexible, must interfere with the first of these conditions, and the agitation produced by the sudden tilting of the lever must affect the other two.

The construction of the clock herewith exhibited, may be explained by reference to the accompanying diagram, (see Plate,) which shows the upper portion of the pendulum rod with the contrivance employed to apply the impelling weight. Two levers are represented, marked $A\ A'$ and $B\ B'$.

The first of these, from its office, is called the remontoir lever —the second, which is employed to control the first, is called the governor. The former is provided at each of its extremities with two hooks (as shown in perspective at the bottom of the diagram). These hooks are designed to carry a very light weight in the form of a small cylinder of metal. This cylinder is slightly indented in the latter at the points where it rests on the hooks, to prevent liability to displacement.

The pendulum-rod is furnished with two semicircular arms, to which, at their extremities, are attached two parallel plates of metal which pass between the hooks of the remontoir lever, and receive the weights, at the proper moments from the hooks, being also slightly notched or indented, to secure uniformity in regard to the point of application of the force.

Both the levers are pivoted in agates, their pivots being in the same horizontal line as the centre of motion of the pendulum. They are also provided with adjustable weights at their extremi-

ties designed to make them tilt slowly in one direction or the other, as may be necessary in order to apply the impulse on either side of the pendulum at the proper moment.

The remontoir lever, when free from control by the other, tends to preponderate toward the right. The governor has a sufficient preponderance in the opposite direction to carry the remontoir with it, when in action, by means of a projection seen at D, which overlaps a corresponding projection on the other, as shown in perspective at the foot of the diagram. This lever in the position exhibited, is caught by a detent at D, and the remontoir lever is free to tilt toward the right, in doing which, it will carry the impulse weight of the extremity A along with it, while it will leave that at the extremity A' on the higher arm of the pendulum. In its swing toward the left, the pendulum will then be impelled by this small weight until it reaches a corresponding inclination on that side, when it will deposit the weight A' upon the hooks of the remontoir, and will take up the other upon the opposite arm.

This mechanism is so simple as to require no further explanation. It only remains to point out in what manner the levers are controlled by the electric battery.

The remontoir lever is insulated by the agates in which it turns. By a tangent spring at its axis it is put into the battery circuit. It has no other contact with the mechanism except where it is acted on by the governor; at which point insulation is also effected; and likewise through the springs shown at C and C', upon which the hooks remotest from the observer alternately rest. These springs are fixed in insulated pins to which are soldered the extremities of the enveloping wires of the magnets M and M'. The pin C is connected with the magnet M', and the pin C' with the magnet M. The continuation of these wires beyond the magnets is not shown; but they are united into a single one, which, after enveloping a third magnet in the time-register (of which no drawing is given), returns to the battery.

From what has thus far been said, it would appear that the moment the hook of the remontoir lever touches either of the springs, C or C', the battery circuit would be complete. But this is not the case: for the hook in contact with the spring is insulated from the lever, and the circuit is only completed at the moment when the pendulum, in its swing, deposits the impulse weight upon the two hooks.

In the position shown, the weight A is supposed to have just been deposited. The magnet M' has acted and has raised the extremity B of the governor to the detent, D. The remontoir lever will now slowly tilt, the gentle motion being necessary to prevent the impulse weight from being thrown off; and the balance weights being so adjusted as to secure the necessary

change of position within the second. A stop prevents the spring *C* from following the hook as it rises.

When the impulse weight *A'* is deposited on the hooks, it is the magnet *M* which acts; and the effects of this, through the bent lever pivoted at *E*, is to release the governor, which, by its preponderant weight will cause the remontoir to tilt again.

Whenever either magnet acts, the magnet of the time-register simultaneously acts, and advances the second-hand one division on the dial.

The remaining parts of the mechanism it is hardly necessary to describe. Adjusting screws are provided to secure the exact position of the pendulum arms, and to cause the impulse to be precisely equal in duration on opposite sides. In adjusting for this latter purpose, the graduated arc on the right, and the index attached to the remontoir lever, are employed. The manner of making the adjustment is obvious.

A pendulum impelled in this manner is subject to the action of no forces which cannot be definitely appreciated. The impelling power is constant and known. The mean resistance of the air may be computed, and even its fluctuations may, if necessary, be taken into account. The irregularities, therefore, which cannot be ascribed to these causes, must be due to imperfect compensation.

There is a possibility that a steel pendulum rod may, to some extent, be affected by the vicinity of the electro-magnets employed in this contrivance. In order to guard against this danger, if it be one, the rod of the pendulum of the clock, here exhibited, is made of brass; and the compensation, which is mercurial, is adjusted accordingly.

The effect of the impelling and resisting forces acting upon a pendulum is to alter its rate of motion; but this circumstance is of no importance, so long as these forces are invariable, like gravity. If, however, any variation occurs, either in the impulse or in the resistance, the time of vibration will be altered. The kind of alteration which occurs, in consequence of a given change of arc, is not, nevertheless, the same, with pendulums impelled on different plans. The recoiling escapement, for instance, accelerates the rate for an increase of arc, while the dead beat retards it beyond the amount which would be due to circular motion, as compared with motion in the cycloid.

The remontoir escapement has the advantage that, though it accelerates the rate of going of the pendulum, it applies invariably the same amount of impelling force at every swing; so that if the pendulum had no work to do in the unlocking of the train, it would be subject to no disturbance of its regularity except such as may be consequent upon fluctuations of atmospheric

density, and upon changes in its own temperature. In studying experimentally the subject of compensation, it would not be difficult to eliminate the effects of the first of these causes, so as to exhibit truly the merit or defect of any given mode of compensation for the expansion and contraction of the materials of the pendulum.

The remontoir escapement does not perfectly fulfil these conditions; but it is believed that the electric clock herewith presented does so completely.

This pendulum has an additional advantage over an escapement remontoir; which arises from the fact that its arc of vibration may be reduced much lower than is at all practicable with a clock driven by a train. All the errors of the pendulum, except those arising from the varying temperature of the rod, increase with the arc. It is believed that this pendulum may be run with so small a motion as to make such errors quite insensible. The degree, moreover, to which external forces affect the rate without altering the arc, is proportional to the forces themselves; and these, in the present case, must necessarily be less as the arc is less.

In order to show in what manner a pendulum of this description differs in its rate of going from one entirely free and vibrating in vacuo, we may take the ordinary differential equation of the angular motion of an oscillating body, and introduce into it terms expressing the forces which in this case are in action, besides gravity. This equation then becomes (φ being the variable arc, measured from the vertical, t the time of one vibration, g the force of gravity, l the length of the simple pendulum, m the maintaining and r the resisting forces, or rather their constant coefficients as compared with gravity).

$$\frac{d^2\varphi}{dt^2}=-\frac{g}{l}\Big(\sin\varphi-rf(\varphi)+mf'(\varphi)\Big).$$

The maintaining force, in the present case, is a weight applied at the extremity of an arm of the pendulum at the height of the centre of motion. Represent the weight by w, the length of the arm by a, and the total mass of the pendulum by M, and we have the value of m equal to $\frac{wa}{Ml}$. The function of φ on which its effect depends is obviously the cosine.

The resistance is, in this case, nothing but the atmospheric inertia, so long as the impulse lasts; after this, the maintaining weight becomes itself a resisting force, and its sign must be changed. The resistance of the atmosphere may be computed on the supposition that the velocity with which a falling body, of equal weight with the pendulum, and presenting an equal surface of resistance, ceases to be accelerated by gravity, is

known. This velocity may be represented by k. Then $rf(\varphi) = \frac{v^2}{k^2}$. For the value of $f(\varphi)$, we consider the velocity to be that which a body would acquire in falling vertically through the height the pendulum has descended from the commencement of its motion, which (if α represent the limit of vibration) is

$$l(\cos\varphi - \cos\alpha). \quad \text{Then} \quad v^2 = 2gl(\cos\varphi - \cos\alpha), \text{ and}$$

$$rf(\varphi) = \frac{2gl}{k^2}(\cos\varphi - \cos\alpha).$$

The equation then becomes

$$\frac{d^2\varphi}{dt^2} = -\frac{g}{l}\left(\sin\varphi - \frac{2gl}{k^2}(\cos\varphi - \cos\alpha) + \frac{wa}{Ml}\cos\varphi\right).$$

If we suppose the impulse to continue to the distance β on the other side of zero, and integrate between the limits α and $-\beta$, we shall have (employing the simpler symbols for the sake of convenience)

$$\frac{d\varphi^2}{dt^2} = 2\frac{g}{l}\Big[\cos\varphi - \cos\alpha + (m-r)(\sin\alpha - \sin\varphi) + r\cos\alpha\,(\alpha - \varphi)\Big].$$

Replacing the trigonometrical functions by their values in terms of the arcs, and rejecting minute terms of higher orders than the second, we shall obtain, after reduction,

$$\frac{d\varphi^2}{dt^2} = \frac{g}{l}\Big[\alpha^2 + 2m\alpha - 2m\varphi - \varphi^2\Big].$$

Hence,

$$dt = \sqrt{\frac{l}{g}}\frac{-d\varphi}{\sqrt{\alpha^2 + 2m\alpha - 2m\varphi - \varphi^2}},$$

$$t = \sqrt{\frac{l}{g}} \times -\text{arc}\sin\frac{\varphi + m}{\alpha + m} + C.$$

And, between the limits α and $-\beta$,

$$t = \sqrt{\frac{l}{g}}\left(\frac{\pi}{2} - \text{arc}\sin\frac{-\beta + m}{\alpha + m}\right).$$

In like manner, if t' express the time during which the impulse weights oppose the motion,

$$t' = \sqrt{\frac{l}{g}}\left(\frac{\pi}{2} - \text{arc}\sin\frac{\beta + m}{\alpha + m}\right).$$

Putting $\tau = t + t'$, the total time of vibration,

$$\tau = \sqrt{\frac{l}{g}}\left(\pi + \text{arc}\sin\frac{\beta - m}{\alpha + m} - \text{arc}\sin\frac{\beta + m}{\alpha + m}\right).$$

Developing these arcs in terms of their sines, according to the ordinary series, taking their difference, and expressing by $\Delta\tau$ the difference between τ and the time of vibration of a free pendulum,

$$\Delta\tau = -\sqrt{\frac{l}{g}}\left[\frac{(\beta+m)-(\beta-m)}{(\alpha+m)} + \frac{1\left[(\beta+m)^3-(\beta-m)^3\right]}{2.3\,(\alpha+m)^3} + \frac{1.3\left[(\beta+m)^5-(\beta-m)^5\right]}{2.4.5\,(\alpha+m)^5}, \&c.\right];$$

which becomes, if we neglect insignificant terms,

$$\Delta\tau = -\frac{2m}{\alpha+m}\sqrt{\frac{l}{g}}\left[1+\frac{\beta^2}{2.\alpha^2}+\frac{\beta^4}{2.4\alpha^4}+\frac{\beta^6}{2.4.6\,\alpha^6}, \&c.\right] \qquad (1)$$

If $\sqrt{\frac{l}{g}}=\frac{1}{\pi}$, as for the free pendulum beating seconds, then, putting ΔT for the total acceleration of the clock in making the number of beats made by the seconds pendulum in a day, and calling the entire remaining value of the second member of the last equation S,

$$\Delta T = \frac{86400\,S}{\pi}. \qquad (2)$$

The terms containing r having disappeared from these expressions, it would seem that the resistance of the air does not affect the time of vibration. These terms, however, have not been eliminated, but only neglected, in consequence of being connected with powers of the arc higher than the square. By preserving them, it may be shown that the resistance of the air produces an effect which is not altogether insensible; rather, however, by consuming some of the disturbing power of m, than by its direct influence. The reason of this is, that the resistance of the air opposes gravity during the descent of the pendulum, but favors it during the ascent.

The value of the foregoing series depends upon the impelling power, and on the ratio between the arc of impulse and the arc of vibration. The necessary impelling force itself, when the ratio just mentioned is fixed, depends upon the absolute magnitude of the arc α. If we assume this arc at two degrees, which is ·035 of the radius taken as unity, and make the ratio of β to α = ·7071, as recommended by Mr. Denison, in his rudimentary treatise on clock and watch work, we may compute the value of m by the following process:—

Assume the pendulum to weigh twenty pounds, which is not far from the weight of that of the clock exhibited; and suppose it to expose a resisting surface to the air of thirty square inches. A column of air of equal base and weight would be about 1250 feet in height, and the velocity with which a fluid of this altitude

would issue from a vessel in consequence of the superincumbent weight, is determined by the formula

$$v^2=2gh.$$

Were the pendulum therefore to move with a velocity equal to the square root of $2\times 32\times 1250$ $(=80{,}000)$, the resistance would be equal to its weight. Hence,

$$k=\sqrt{80{,}000.}^*$$

And $r\ (\cos\varphi-\cos\alpha)=\frac{2gl}{k^2}\times\frac{\alpha^2-\varphi^2}{2}=\frac{gl(\alpha^2-\varphi^2)}{80{,}000}$.

This being the coefficient of the variable resistance, the total effect of the resisting force may be found by integrating the expression,

$$\frac{gl(\alpha^2-\varphi)^2}{80{,}000}g\,dt,$$

between the limits α and $-\alpha$. Employing the symbol r, instead of the fractional coefficient, and taking the value of dt as given above, we have, calling the total resistance R,

$$R=\int\frac{rg}{2}(\alpha^2-\varphi^2)\sqrt{\frac{l}{g}}\frac{-d\varphi}{\sqrt{\alpha^2+2m\alpha-2m\varphi-\varphi^2}}.$$

Integrating between the limits α and $-\alpha$, and putting $\sqrt{\frac{l}{g}}=\frac{1}{\pi}$,

$$R=\frac{rg}{2\pi}\left[\left(\frac{\alpha^2-2m\alpha}{2}\right)\left(\frac{\pi}{2}+\text{arc}\sin\frac{\alpha-m}{\alpha+m}\right)+(\alpha+3m\sqrt{m\alpha})\right].$$

Since m is very minute in comparison with α, we may make $\frac{\alpha-m}{\alpha+m}=1$, and also neglect $-2m\alpha$. The small positive term at the end becomes insensible, when multiplied by the general coefficient, in which k^2 is a divisor—the term itself being insignificant compared with π, with which it is connected by the sign $+$. The errors thus introduced, besides being insensible, are in opposite directions, and nearly balanced. The simplified expression is then,

$$R=\frac{rg\alpha^2}{4}=\frac{g^2l\alpha^2}{2k^2}.$$

This resistance extends over the whole arc of vibration; but the maintaining power acts effectively only between the limits β

* This computation supposes the resisting surface to be plane. The actual value of k will vary with the form of the pendulum; and will ordinarily be considerably greater than it is here found to be. The disturbing effects upon the pendulum, deduced further on, will therefore be materially less than represented; since a less impelling force will be required to maintain the motion than the calculation exhibits. The actual value of k may be pretty nearly ascertained for bodies of regular shape, by considering the inclination of their surfaces to the direction of motion.

and $-\beta$, or during the time found by integrating the expression already given for $d\,t$ between the same limits. Then,

$$mg(t-t') = \frac{2mg}{\pi}\left[\frac{\beta}{\alpha} + \frac{1.\beta^3}{2.3\alpha^3} + \frac{1.3\beta^5}{2.4.5\alpha^5} + \frac{1.3.5\beta^7}{2.4.6.7\alpha^7}, \text{\&c.}\right] \quad (4)$$

Or, putting S for the sum of the series within the brackets,

$$mg\,(t-t') \doteq \frac{2\,m\,g\,S}{\pi}, \text{ which must equal } R.$$

Therefore,

$$\frac{2\,mg\,S}{\pi} = \frac{g^2\,l\,a^2}{2\,k^2}; \text{ and } 4\,Sk^2\,m = g\,l\,\alpha^2\,\pi,$$

Whence,

$$m = \frac{w\,a}{M\,l} = \frac{g\,l\,\alpha^2\,\pi}{4\,S\,k^2}; \text{ and } w = \frac{Mg\,l^2\alpha^2\pi}{4\,a\,S\,k^2}. \quad (5)$$

The foregoing series rapidly converges, and if $\beta = \cdot 707\,\alpha$, its sum is $\frac{1}{2}\pi$. Putting α, the length of the pendulum arm, measured at right angles to the pendulum rod from the centre of motion, $= 3$ inches, and employing for the other symbols, the values heretofore given, we shall obtain for m and w the numerical values,

$$m = \cdot 000001597.$$

$$w = 2\cdot 914 \text{ grains, or 3 gr. nearly.}$$

Returning to the expressions (1) and (2), with the value of m thus determined, and still employing for β the value $\cdot 707\,\alpha$, the sum of the series within the brackets in (1) will be found to be 1·384. And therefore $\varDelta\,T$, or the daily acceleration, will be,

$$\varDelta\,T = \frac{2 \times 86400 \times \cdot 000001597 \times 1\cdot 384}{3\cdot 14159 \times \cdot 035001597} = 3\cdot 473 \text{ seconds.}$$

Whence it appears that this pendulum, in order to beat seconds, must be about three one thousandths of an inch longer than one entirely free.

In order to investigate the liability of this pendulum to change of rate, we must observe that, at a constant temperature, it is impossible that there should be a change of rate without a change of the arc of vibration; and further, that there is no cause in operation to change the arc, except variations of density in the air. In expression (5) we observe that α^2 varies as k^2; but it is evident that k^2 varies inversely as the density of the atmosphere. Or, putting D for the density,

$$\alpha^2 \propto k^2 \propto \frac{1}{D}.$$

$$2\,\alpha\,d\,\alpha \propto 2\,k\,d\,k \propto -\frac{d\,D}{D^2}.$$

Hence,

$$\frac{2\,d\alpha}{\alpha} \propto \frac{2\,dk}{k} \propto -\frac{dD}{D}.$$

And,

$$\frac{d\alpha}{\alpha} \propto -\frac{dD}{2\,D}.$$

Putting the mean density of the air $=1$, and substituting a finite difference for dD, we shall find that the corresponding finite difference of α will be but half as great in proportion to the entire arc, as the fractional change of density. If, therefore, under a constant temperature, the mercury in the barometer rise or fall one inch, or a change of density occur equal to one thirtieth of the mean, the arc of vibration will change one sixtieth part of the whole; that is to say, if the value of α is 2°, the arc will fall off, or increase to the amount of 2′.

To compute the effect of such a change upon the quantity ΔT, we may regard the series in equation (1) as being sensibly constant, and then, representing the whole expression, except the denominator of the coëfficient fraction, by Q, and omitting the insignificant term m from the denominator, we shall have,

$$\Delta\,T = -\frac{Q}{\alpha}, \text{ and } d\Delta\,T = \frac{Q\,d\alpha}{\alpha^2}.$$

Substituting $-\alpha\Delta\,T$ for Q and reducing, we have,

$$d\Delta\,T = -\frac{\Delta\,T\,d\alpha}{\alpha},$$

which, in the extreme case supposed above, gives a diminution of the daily acceleration equal to ·058 sec. This change is, unfortunately, in the same direction as that of the circular error: but it is proportional to the quantity $\Delta\,T$ itself, which is directly as the maintaining power; which, again, as appears from equation (5), is as the square of the arc. Hence, therefore, the importance of reducing the arc of vibration, and the near approach to insensibility of the errors arising from its variations, when it is small. Were the arc only 1° on each side of the vertical, the error would be between one and two hundredths of a second per day. Were it half a degree, the clock, from this cause, would not be an entire second in error in nine months.

The chief object had in view in the construction of the electric clock herewith exhibited, has been to secure the reduction of the arc of vibration. The work having just been completed, opportunity has not yet been allowed for experimentally deciding the question how great a reduction of arc is practicable; but the principle of the mechanism exacts no larger motion than

may be necessary to make and break electric contacts. The reduction of the arc α may be equally effected by either of two methods—either by reducing the impulse weights, or by shortening the duration of the impulse. When the arc is considerable, the former method appears preferable; when it is very small, there is not much to choose between the two; except that, by constantly reducing the impulse weights, they may perhaps become inconveniently small.

To return to the subject of compensation for variations of temperature, it may be observed that, while every pendulum is liable to be disturbed by the forces other than gravity acting upon it, and while these forces are not all of them subject to law, so that their effects can be exactly predicted and allowed for, it is not surprising that methods of compensation theoretically good should have failed to satisfy in practice. In the electric clock here presented, should its performance accord with expectation, and should it be found practicable to reduce the arc of vibration as far as it is at present believed to be, there will evidently be no sensible change of rate arising from any cause whatever, except expansion or contraction. If then the rate does actually change, the cause of error will be directly indicated; and the proper mode of correction may be made a subject of intelligent study.

A doubt has been already intimated above, whether the complaint made of the performance of the mercurial compensation, and of the glass jars as connected with it, is well founded. If the pendulum rod descends into the mercury, it would seem that there could be no great difference in the fluctuations of the temperature of the two metals. As the changes come from without it will be the rod which will be most directly exposed to them; but the capacity of the mercury for heat is so much less than that of steel, that its changes take place with correspondingly greater rapidity. If the smaller bulk of the rod in proportion to its surface, be in its favor, the remedy would be to make the rod larger, or to dispose the mercury in an annular vessel. But, at any rate, it is easy to make the containing vessel of iron according to the plan of Mr. Dent; and if this is done, and the expedient last suggested is adopted, of introducing the mercury into the annular space between two cylinders, it would seem that the mercurial compensation might be made quite perfect. As a final security against irregularities in the receiving of heat or parting with it, the entire surface both of the rod and of the containing vessel might be made uniform in character: which is done in the present clock by gilding. For a comparison of the performance of the compensation in glass and in iron, different jars are provided, which will be substituted for each other at intervals of several months. A brass cover, externally gilded, is also

provided, to be placed over either the iron or the glass jar, for the purpose of observing the effect of change of external surface.

These are some of the arrangements which have been made for future use in the experimental examination of the question under consideration. They would not have been brought to the notice of the Association until after having been instrumental in securing some results, were it not for the fact that no other opportunity will occur of exhibiting the clock itself—its completion having taken place just as the Association are meeting—and the constructor being on the point of forwarding it to the University of Mississippi, where it belongs. The observatory of the university is now in progress of erection, and it will be some time before the large transit instrument which is to be provided will be set up. It will be practicable, however, with less perfect facilities, to make some of those observations for which this clock is designed; and the conclusions to which such observations may lead will be communicated hereafter.

ART. XXIII.—*Enumeration of Ferns collected by Mr. Charles Wright, in Eastern Cuba in* 1856–7; by DANIEL C. EATON.

THIS enumeration has been prepared for the benefit of the subscribers to Mr. Wright's Cuban collections. It is unavoidably imperfect, since my materials for identifying tropical ferns are scanty, and, indeed, I should not venture to print it, were it not for the kindness of Sir W. J. Hooker, who has examined and named for me several of the more obscure species. Mr. Wright is again collecting in Cuba: after his return a supplement to this list will probably be published.

774. Hemionitis palmata, *Linn.*

775. Antrophyum subsessile, *Kunze, Analect.* p. 29, t. 19.

776. A. lanceolatum, *Kaulf.*

777. Gymnogramme tartarea, *Desv.*

778. G. sulphurea, *Desv.*

779. G. trifoliata, *Desv.*

780. Xiphopteris serrulata, *Kaulf.*

781. Meniscium sorbifolium, *Willd.; Langsd. and Fisch. Ic. Fil.* t. 4.

782. M. sorbifolium, *Swartz.* This is probably but a variety of the last with narrower pinnæ.

783. Gymnopteris aliena, *Presl.* (Acrostichum alienum, *Swartz.*)

784 & 785. Olfersia cervina, *Kunze; Hook. Filices Exoticæ,* t. 43. (Acrostichum cervinum, *Swartz.*)

786. Polybotrya osmundacea, *Humb. & Bonpl.?*

787. Lomariopsis sorbifolia, *Fée, Hist. des Acrostichacées,* p. 69, var.? Perhaps this Fern deserves to be described as a new species, but I am unwilling to name and describe it from my present scanty materials.

788. Gymnopteris nicotianæfolia, *Presl.* (Acrostichum nicotianæfolium, *Swartz.*)

789. Elaphoglossum ciliatum, *T. Moore*, *Index Filicum*, p. 8. (Acrostichum Preslianum, *Fée*, *2me. Mém.* p. 46, t. 24; *Hook. in litt.*)

790 & 791. E. latifolium, *J. Smith*, *Catal. Kew Ferns*, p. 3. (Acrostichum latifolium, *Swartz; Hook. Fil. Exot*, t. 42.)

The name Elaphoglossum is retained for this genus because there was no representative of it in the original genus Acrostichum, (*Linn. Amœn. Acad.* i, p. 268,) which contained only two real Acrostichaceæ, A. aureum and A. lanceolatum (Leptochilus Linnæanus, *Fée*), the former of which must keep the name Acrostichum.

792. Hymenodium crinitum, *Fée*, *2me. Mém.* p. 90. (Acrostichum crinitum, *L.; Hook. Fil. Exot.* t. 6.)

793. Elaphoglossum.

794. E. piloselloides, *T. Moore*, *l. c.* p. 13. (Acrostichum piloselloides, *Presl.; Hook. l. c.* t. 29.)

795. Goniophlebium incanum, *J. Smith.* (Polypodium incanum, *Swartz.*)

796. Pleopeltis angustifolia. (Polypodium elongatum, *Mettenius*, *Polypod.* p. 88, non Pleopeltis elongata, *Kaulf.*)

797. Campyloneuron tæniosum, *Fée*, *Gen. Fil.* p. 258. (Polypodium tæniosum, *Willd.; Mettenius*, *l. c.*, p. 52.)

798. Goniophlebium piloselloides, *J. Smith*, *in Hook. Jour. Bot.* 4, p. 56. (Polypodium piloselloides, *L.*)

799. Campyloneuron.

801. C. Cubense, *Fée*, *Iconogr.* p. 14 and 129, t. 3. (Polypodium tæniosum, var. *Mettenius*, *l. c.*)

803. Phlebodium aureum, *R. Br.; Hook. Gen. Fil.* t. 112. (Polypodium aureum, *L.* Chrysopteris aurea, *Link*, *Fil.* sp. p. 121.)

804. Goniophlebium neriifolium, *J. Smith*, *l. c.* (Polypodium neriifolium, *Swartz.*) *Hook. in litt.*

805. Polypodium sororium, *H. B. K.*

806. P. pectinatum, *L.*

807. P. Funiculum, *Fée*, *Iconogr.* p. 12, t. 18.

808 & 810. P. suspensum, *L.; Hook. in litt.*

809. P. Camptoneuron, *Fée*, *Gen. Fil.* p. 237, *Iconogr.* p. 60, t. 23.

811. P. trichomanoides, *Swartz.*

812. P. hastæfolium, *Swartz; Hook. & Grev. Ic. Fil.* t. 203.

813. Goniopteris reptans, *Presl.* (Polypodium reptans, *Swartz.*)

814, 816 & 865. Polypodium (Phegopteris) sanctum, *Swartz.*

815. Lastrea pubescens, *Presl.* (Aspidium pubescens, *Swartz; Vid. Hook. & Grev. Ic. Fil.* t. 162.

817. Goniopteris tetragona, *Presl.* (Polypodium tetragonum, *Swartz; Schkuhr*, *Fil.* t. 18b. Phegopteris tetragona, *Metten. Fil. Lips.* p. 84.) *Hook. in litt.*

818, 819 & 822. Lastrea patens, *Presl.* (Aspidium patens, *Swartz.*)

This is a common and most variable fern in the Southern States from Florida to Louisiana and Texas. It resembles Nephrodium molle, and was mistaken for that species by *Kunze.* (*Am. Jour. Sci.* vi, p. 83.)

820. L. coutermina, *Presl.* (Aspidium conterminum, *Willd.*) *Hook. in litt.*
823. Nephrodium deltoideum, *Desv.* (Aspidium deltoideum, *Swartz; Metten. Phegopt. und Aspid.* p. 93.)
824. N. Skinneri, *Moore, Index Filicum,* p. 104. (Aspidium Skinneri, *Hook. Ic. Pl.* t. 924.)?
825. N. stenopteris. (Aspidium stenopteris, *Kunze, Fil.* 2, p. 48, t. 120.)
826. Nephrolepis exaltata, *Presl.*
827. Goniophlebium loriceum, *Fée, Gen. Fil.* p. 255. (Polypodium loriceum, *L.*)
829. Polystichum triangulum, *Fée.* var. (Aspidium triangulum, *L.* var. laxum, *Hook. Fil. Exot.* t. 33. Polystichum ilicifolium, *Fée. Gen. Fil.* p. 279, *Iconogr.* p. 21, t. 6.
830. Lastrea Melanochlamys, *Moore, l. c.* p. 96. (Aspidium Melanochlamys, *Fée, Gen. Fil.* p. 294.)
831. L. exculta, *Moore, l. c.* p. 91. (Aspidium excultum, *Metten. Phegopt. und Aspid.* p. 69. Aspidium lætum, *Moritz.*) *Hook. in litt.*
832. Polystichum platyphyllum, *Presl.* (Aspidium platyphyllum, *Willd.* Phegopteris platyphylla, *Metten, l. c.* p. 122.)
833. Aspidium cicutarium, *Swartz; Metten. l. c.* p. 117.
834. A. macrophyllum, *Swartz; Metten. l. c.* p. 122.
835. A. trifoliatum, *Swartz.*
836. Oleandra nodosa, *Presl.*
837. Asplenium serratum, *L.; Hook. Fil. Exot.* t. 70.
838. H. marginatum, *L.; Hook. l. c.* t. 73. (Hemidictyum marginatum, *Presl.*)
840. A. serra, *Langsd. & Fisch. Ic. Fil.* t. 19.
842. A. dimidiatum, *Swartz.* (A. zamiæfolium, *Kunze, Fil.* p. 103, t. 48.)
833. A. falcato, *Lam.*, affine.
844. Fadyenia prolifera, *Hook. Gen. Fil.* t. 58, B; *Fil. Exot.* t. 36. (Aspidium Fadyenii, Mettenius, *Fil. Hort. Lips.* p. 95. Asplenium proliferum, *Swartz.*)
845. Asplenium, salicifolio, *L.* affine.
846. Diplazium grandifolium, *Swartz.; Hook. in litt.*
847. Diplazium.
848. Asplenium bidentatum, *Willd.* ?
849. A. auricularium, *Desv.*
850 & 851. A. rhizophorum, *Swartz; Hook in litt.*
852. A. bisectum, *Swartz.*
853. A. dentatum, *L.; Hook. & Grev. Ic. Fil.* t. 72.
854. A. formosum, *Willd.; Hook. Fil. Exot.* t. 16.
855 & 856. A. cicutarium, *Swartz.*
857. A. fragrans, *Swartz; Hook. in litt.*

858 & 859. Onychium strictum, *Kunze, Fil.* 2, p. 11; *Hook. Sp. Fil.* 2, p. 123.

860. Gymnogramme leptophylla, *Desv.*

861. Asplenium pumilum, *Swartz.*

862. Didymochlæna sinuosa, *Desv.* (D. truncatula, *J. Smith.*)

863. Blechnum occidentale, *L.*

864. Lomaria decresceus, *Fée, Gen. Fil.* p. 68, *Iconogr.* p. 24, t. 9. (L. attenuata, *Willd., ex Hook. in litt.*)

865. Vittaria lineata, *Swartz*—(the longer specimens.)

865bis. V. sp. ign.—(the shorter specimens.)

866. Pleurogramme immersa, *Fée. 3me. Mém.* p. 37, t. 4. *Hook. in litt.*

867. Pteris pedata, *L.; Hook. Sp. Fil.* 2, p. 208. *Fil. Exot.* t. 34. (Doryopteris pedata, *J. Smith.*)

868. P. leptophylla, *Swartz; Hook. Sp. Fil.* 2, p. 216. (Litobrochia leptophylla, *Fée, Gen. Fil.* p. 135.)

869. P. mutilata, *L.; Hook. l. c.* p. 164, t. 131.

870. P. denticulata, *Swartz; Hook. l. c.* p. 215. (Litobrochia denticulata, *Fée, l. c.*)

871. P. longifolia, *L.*

872. P. aquilina, *L.* var. caudata, *Hook. l. c.* p. 196.

873. P. aculeata, *Swartz; Hook. l. c.* p. 224. (Litobrochia denticulata, *Fée, l. c.*)

874. Adiantum macrophyllum, *Swartz; Hook. Fil. Exot.* t. 55.

875. A. trapeziforme, *L.*

876. A. tenerum, *Swartz.*

877. A. concinnum, *H. B. K.*

878. A. fragile, *Swartz.*

879. A. pulverulentum, *L.*

880. A. cristatum, *L.; Hook. in litt.*

882. A. villosum, *L.*

883. Pteris laciniata, *Willd.; Hook. Sp. Fil.* 2, p. 176, t. 132.

886. Polypodium (Phegopteris) barbatum, *Kunze in Linnæa*, 9, 52. *Hook. in litt.*

887. Cheilanthes microphylla, *Swartz.*

888. Hemitelia horrida, *R. Br.; Hook. Sp. Fil.* 1. p. 30, t. 15; *Fil. Exot.* t. 69.

889. Alsophila.

890. A. muricata, *Hook. in litt.*

891. Cyathea Serra, *Willd.* var.?

892 & 893. C. arborea, *Smith; Hook. Sp. Fil.* 1, p. 17.

894. Hypolepis repens, *Presl.*

895. Dicksonia cicutaria, *Swartz.*

896. Davallia polypodioides, *Don.*

897. Dicksonia Plumieri, *Hook. Sp. Fil.* 1, p. 72.

898. Davallia aculeata, *Swartz.*

899. D. uncinella, *Kunze, Fil.* 2, p. 96, t. 140.

900. Trichomanes crispum, *L.*

901. T. macroclados, *Kunze, l. c.* p. 72, t. 130.

902. T. Radicans, *Swartz; Hook. in litt.*

903. T. anceps, *Hook. Sp. Fil.* 1. p. 135, t. 40?
904. Hymenophyllum sericeum, *Swartz.*
905. H. hirsutum, *Swartz.*
906. 907 & 908. Trichomanes pyxidiferum, *L.* var.
909. T. angustatum, *Carm.; Hook. & Grev. Ic. Fil.* t. 166; *Hook. in litt.*
910. Metzgeria fucoides, *Nees & Montagne.*
911. Trichomanes membranaceum, *L.*
912 & 913. T. muscoides, *Swartz.*
914. T. apodum, *Hook, & Grev. Ic. Fil.* t. 117.
915. T. reptans, *Swartz.*
916. T. holopterum, *Kunze, Fil.* 1, p. 185, t. 77?
917. Hymenophyllum asplenoides, *Swartz.*
918. Hymenophyllum.
919. H. undulatum, *Swartz.*
920. H. abruptum, *Hook. Sp. Fil.* 1, p. 88, t. 31.
921. Gleichenia pubescens, *Willd.*
922. G. dichotoma, *Willd.*
923. Nephrodium Serra, *Desv. Ann. Linn.* 6, p. 253. (Aspidium Serra, *Swartz.*)
924. Danæa nodosa, *Smith; Hook. & Grev. Ic. Fil.* t. 51.
925. Lygodium Poeppigianum, *Presl. Suppl. Tent.* p. 103?
926. Schizæa dichotoma, *Swartz.*
927. Rhipidopteris peltata, *Fée. 2me. Mém.* p. 78. (Acrostichum peltatum, *Swartz.*)
928. Anemia adiantifolia, *Swartz.*
929. A. Breuteliana, *Presl. l. c.* p. 90. (A. Mandioccana, *Hook. Gen. Fil.* t. 90.)
930. Ophioglossum vulgatum, *L.* (Ophioglossum reticulatum, *L.*)

Dr. J. D. Hooker in the Flora of New Zealand unites all the species of Ophioglossum proper, and Sir W. J. Hooker, in his and Dr. Arnott's Flora of Great Britain, says he is ready to acknowledge the correctness of this view.

931. Psilotum triquetrum, *Swartz.*
932. Lycopodium cernuum, *L.*
933. L. reflexum, *Swartz; Hook. in litt.*
934. L. linifolium, *L.*
935. L. verticillatum, *L.*
937. L. taxifolium, *Swartz.*
938, 939 & 940. Species of Selaginella.

ART. XXIV.—*Some observations on the Motions of certain Winding Plants;* by WM. H. BREWER, Prof. of Chemistry in Washington College, Pa.

IT has long been recognized as a general law, that green plants during their growth grow towards the light, but all the botanical works that have come under my observation, which speak of winding plants and tendrils in this connection, speak of them as forming, practically, an exception to this law, that is, that they turn towards some "*dark*" or "opaque" object. That they do turn towards a solid support has long been observed, the fact is undisputed, and the cause of this motion, instinctive as it were, towards some solid around which they may twine has always been given, directly or inferentially as the absence of light, or more properly the opacity or non-luminous character of the support. I have been unable to find any account of experiments on this property of certain plants or of certain organs of plants further than merely to show the fact, that it exists.

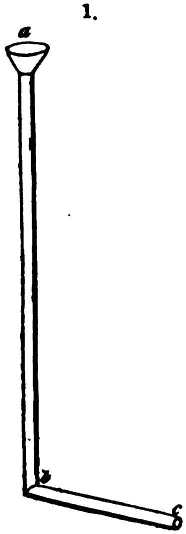
During the summer of 1855 I made some observations on the growth of a hop vine (*Humulus*) to ascertain more precisely the relations between the rate of growth at different hours of the day, and the temperature, clearness and other atmospheric conditions. To effect this the vine was measured at stated hours several times each day, and the better to do this it was not allowed to wind around, but was trained up one side of a smooth pole. Incidental to the desired observations, it was noticed that during the heat of the day, although the plant sometimes grew several inches, it grew towards the light with only a very slight tendency to wind around the pole, while during the night, or on cold days, while the rate of growth was slower it would assume the spiral and cling closely to the support. On one occasion, when a number of plants were only from one to two feet high, a slight fall of snow took place which remained a day or more, and in a few hours, all the plants which had sprung up from the ground and remained perfectly erect until this time, inclined at a high angle towards a lattice which was artificially heated.

It was also found that they would climb a transparent glass tube almost or quite as readily as an opaque stick. These and similar observations at other times suggested to me that the cause of the motion towards a support was not owing to any influence of light, or its absence, but rather to *heat*, and to elucidate this subject a series of experiments were made at Ovid, N. Y., during the last summer.

These consisted in the main of presenting a warm and a cold support to some winding plant, and then observing if it manifested any preference. The plants experimented on were the

common Lima bean (*Phaseolus lunatus* L.) and the common morning glory, (*Convolvulus purpureus* L.) The general plan was to keep the plants in a closed room during the day and early part of the evening, where the air could be kept at a rather high and nearly constant temperature, and then remove them for the night into another room where the temperature was several degrees lower than the first, where the warm and cold supports were presented to them. This room was also closed and darkened that neither currents of air nor morning light should interfere with the accuracy of the experiments.

1.

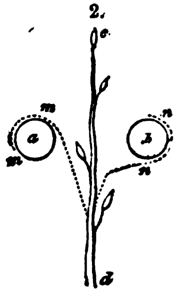


For the supports tin tubes were used, of the shape given in the figure, having a funnel *a*, at the top, and an elbow *b*, at the bottom, forming an obtuse angle. These were about an inch in diameter, similar in size and shape, and the vertical part painted black. These could be kept cool by filling with cold water, and if desired by placing ice in the funnel *a*, and could be warmed and kept at any desired temperature higher than the air, by a small spirit lamp placed under the end *c*. For the use of glass and other materials, an elbow of tin was employed, and then the straight tubes fitted with a cork. To test the effect of colors, tin tubes were painted of various colors, and in some cases colored paper was pasted around them. White, black, red, pink, green, blue, and yellow, were tried. When in use the tubes were held in a nearly vertical position, about five inches apart, one filled with well-water a few degrees colder than the surrounding air, the other filled with warm water and kept heated to any desired temperature by a spirit lamp, generally from 5° to 12° Fahr., above the temperature of the air in the room. The plant was placed at the beginning of the experiment so as to be midway between the two tubes, not exactly parallel with them, but crossing their plane at a low angle. It was allowed to remain without disturbance from 9 P. M. until 7 A. M., and its position, the temperature of the air and the water in the tubes and other conditions accurately noted at the beginning and close of each experiment.

Many preliminary experiments were made to devise means to avoid the various causes of interference, and to test and perfect the apparatus, and they so far succeeded that I consider the results given as reliable. After these, a series of fifty-two experiments were carefully made, of which nineteen were with Convolvulus, and twenty-three with Phaseolus. These gave in thirty-six cases results confirmatory, that is, the vines turned to

or towards the warmed tube, in fourteen cases they showed no especial preference, and in only two cases did they turn to the cold tube. In these fifty-two experiments, the right tube was heated twenty-five times, and the results were nineteen confirmatory and six indifferent; the left tube twenty-seven times, and the results seventeen confirmatory, eight indifferent and two contradictory, (that is, turned to the cold tube). In both of these latter cases the nights were exceedingly hot (one was 84° F.) and the experiments were in a room in which the sun had shown a part of the day and the walls had become heated, so that on closing the room the temperature rose during the night several degrees; the heat radiated from the walls doubtless effected the results. During the cooler nights, or when the temperature was below 65° F., the results were most marked, and generally in the morning the point of the vine, left the evening before midway between the two tubes, would be found not only moved towards the heated tube but would be closely twining around it, the point of growth lying closely against the surface. The right and left tubes were in turn heated on alternate nights and also they were made to exchange places occasionally. As both of the plants experimented on wind to the left, (the right according to Bischof) it will be readily seen that it makes much difference which tube is heated, when the plant is placed in the position relative to them which I have described, in the form the spirals will assume.

2.



Thus, let *a* and *b* be the sections of the two tubes, and *c* the extremity of the plant *c d*, at the beginning of the experiment. Then if *a* be heated (the one I have assumed as the left tube in the description) the plant will gradually assume the position of the dotted line *m m*, by simply turning to the left. If however, the right tube, *b*, be heated, the plant will take the direction of the dotted line *n n*, by first rising vertical and then passing behind and around the tube.

The room in which all the experiments (with the tubes) were conducted had but one window, opening west, which at night was carefully closed and darkened. In half an hour, sometimes in a few minutes, after the light had been admitted in the morning, the growing point of the vine would slightly relax the hold with which it would press against the support, and then during the day its growth would be towards the light. During this period, the tendency to grow in the direction of the light was vastly greater towards the warmed tube; in fact, the Phaseolus seemed to be entirely insensible to the latter during this time, and the Convolvulus nearly so.

I found that the Phaseolus, if grown in a room in which the temperature was high and nearly constant, not falling more than 3° or 4° F. during the night, would wind about a support in such very long loose spirals that it could not retain its position, but would slide down from time to time, and this same plant, when allowed the influence of cooler nights, would then wind in shorter spirals and cling with its accustomed tenacity to the smooth stick which served as a support. Furthermore, I found that by placing a plant in such a position that the sun could shine on its growing extremity, but not on its support, and changing it occasionally to keep up the conditions, turning it so that its tendency to grow towards the light was in opposition to that of its winding, and then keeping it at night at nearly the same temperature that it had during the day, I could entice it entirely away from the support until a length of several feet of the vine was pendant and unsupported.

These indicate the same fact sustained by the experiments with the tubes, viz., that plants wind best when the support is warmer than the air. This condition is fulfilled in nature at night, as the solid absorbs the sun's rays by day and cools more slowly than the surrounding air by night. I am aware that such plants will wind in nature around cold supports, such as growing plants of other species, but I doubt if their first direction towards them, before the contact is more than accidental.

There appears to be much difference in the force with which different species of winding plants assume the spiral. The Convolvulus seemed much more sensitive to the influence of heat than the Phaseolus, before it was in contact with anything, and much more independent of it afterward, for when once in contact with a support it could not be induced to again leave it, and would follow a piece of twine or slender rod apparently as readily as a more solid material. Many experiments seemed to indicate that *contact* with the support modifies the force with which plants assume the spiral, that in fact, although the fibres of the plant are somewhat spiral about its axis before contact, afterwards, these spirals are shorter, and only then will the whole plant assume a spiral form as if to enclose something in its turns.

This was beautifully shown by introducing the end of a vine into a thin glass tube at night; the fibres of the plant would assume a shorter spiral and sometimes the plant itself would wind around on the inner surface of the tube in the same form and direction as if it had enclosed some cylinder in its turns, while plants not so treated would remain nearly straight and their fibres less spiral.

The experiments with tubes of various colors gave no results materially different from the others.

These experiments were more striking than was anticipated, but were prosecuted under difficulties which prevented their being completed.

They are intended as the preliminaries to more extended and complete investigations in the same direction, to be continued at some future time, embracing the interesting question, whether tendrils are influenced by the same causes and follow the same law, also some things relating to the direction of winding plants, the length of their spirals compared with their diameter, the direction of the spiral growth of various trees, &c. Some observations have already been made on all of these subjects except that of tendrils.

The experiments performed, indicate, I think,

1st. That during the day winding plants like others grow towards the light.

2d. That they possess the property of turning towards some solid support.

3d. That this is more manifest by night than by day, and the most so on cool nights following hot days.

4th. That this is not controlled by any influence of light or its absence, exerted by the support.

5th. That heat is the controlling cause, and that such plants will only turn (unless it be accidentally) towards a support, the temperature of which is higher than that of the surrounding air.

6th. That the color and material of the support exert no influence further than that they influence the radiation and absorption of heat; and

7th. That when such plants are in actual contact with some support, the tendency to wind spirally around it is much greater than they manifested in order to reach it.

ART. XXV.—*On some Anomalies in the Florida Gulf Stream, and on their further Investigation;* by Lieut. E. B. HUNT, Corps of Engineers, U. S. A.

(Read before the American Association for the Advancement of Science, at the Baltimore Meeting, May, 1858.)

THERE is perhaps no portion of the ocean waters which has been so imperfectly studied, in proportion to its importance, as that from the west end of Cuba through the Gulf of Florida. The whole commerce of the Gulf of Mexico is directly concerned in whatever investigations shall more accurately define the currents or other physical peculiarities of that portion of the Gulf Stream area from the line joining Cape Antonio to Cape Catoche, and the latter with the Tortugas, thence to the eastward through that grand channel bounded on the north and

west by the Florida Reef and mainland, and on the south and east by Cuba and the Bahama banks. As it is the natural outlet for the products of the entire gulf coast and of the valley of the Mississippi, the present commerce following this route, vast as it is, must ultimately be so far exceeded, that it will seem almost insignificant in comparison with that which another half century will direct through this channel. The character of this navigation, no less than its amount, is such as to demand the most careful study of the currents, by which it is so largely influenced. All are so familiar with the immense annual losses to commerce by wrecks and disasters on the Florida Reefs and Bahama Banks, that a simple reference to the fact will abundantly vindicate the importance of carefully gathering whatever knowledge can give greater safety to this navigation. The high extra premiums for marine insurance by this Florida channel route, afford another striking testimony to the risks of this navigation; but I think it right to remark here, that, from the best information I could obtain at Key West, the Florida channel insurance rates are very much too high, and are annually giving exorbitant profits to the insurance companies. This makes it the interest of these companies to exaggerate the dangers of this passage; and it is believed that they are, on this account, less averse to wrecks, and less strict in distinguishing collusive or fraudulent wrecks than they should be. A reduction of rates must soon be made, if we may judge from the fact that owners are, to a considerable extent, becoming their own insurers, in preference to paying the established rates. The new light-houses and coast-survey beacons have added much to the security of this route, and the business of wrecking at Key West is, on the whole, diminishing, although commerce is of course increasing. Making all due abatement for the exaggerations of the terrors of the Florida Straits, and for the increased aids to navigation, there still remains a very serious annual marine loss, due almost entirely to the imperfect acquaintance of navigators with the peculiarities of the route, and especially with the currents. Misled by false or imperfect views about the Gulf Stream, and other currents prevailing here, sea captains are frequently so unfortunate as to run directly on the reefs, while they suppose they are well out in the channel way. I cannot but think that a system of reef pilotage, properly organized and well conducted, would lead to a great reduction in the number of casualties. By taking and leaving well-trained pilots at the entrance to, and exit from, the region of danger, the numerous casualties due to the imperfect knowledge of sea captains would be in great part obviated. Skillful pilots, constantly engaged in taking vessels through the channel, would grow more and more certain of all the essentials for secure passages, until it would become a gross

offence to lose a vessel, except from causes truly extraordinary. It is obvious that such pilots should be so situated that no possible advantage could accrue to them in case of wreck, while a premium should be awarded for each safe pilotage. Were such a system in full operation, it would be a proper rule that a vessel failing to take a reef pilot should forfeit its insurance, except when no pilot could be procured. A great difficulty in accomplishing this plan except by the combined action of the insurance companies, is found in the fact that three national jurisdictions enter the field of pilotage.

A first essential for giving greater security to the Florida channel navigation is a more correct determination of the currents by which vessels are affected during the transit. Having spent the last winter at Key West, I was led to inquire about these currents with some particularity, and, as a result, was brought to the opinion that the prevalent views are very seriously at fault. There are many facts quite incompatible with the common notions of a vast current constantly sweeping around the Gulf of Mexico, and thence pouring in full volume through the Gulf of Florida. I will here cite some notes of testimony given me by various persons specially acquainted with the matters in view. They were questioned more particularly with reference to facts and opinions touching a southwesterly current prevailing more or less between the easterly Gulf Stream and the Florida reef. Such a counter or eddy current is definitely indicated on Jeffrey's map of 1794, by a dotted line, above which is written, "North of this line is a current setting southwestward, unless when the wind is at north or east, which winds admit of no southwest;" and, "South of this line the current of the Florida stream sets always northwardly."

Capt. Geiger, who for over thirty years has been observing the waters of this vicinity, most of that time having acted as a pilot off Key West harbor, and who is perhaps better acquainted than any other person with the currents there prevailing, gives the following statement of facts.

A strong north or northeast wind keeps the Gulf Stream back, and makes a westerly current near the shore. During June, July, and August, the westerly current prevails more than the easterly current from five to fifteen miles from the reef. The direction of the current depends mostly on the wind. The westerly current prevails for from one third to two fifths the entire time from year to year, for from two to fifteen miles outside the reef off Key West. He has known it twenty-five to thirty miles off Sand Key. When the Gulf Stream is strongest on the Cuba shore, the westerly current is strongest on the north side; and when it is weakest along the Cuban shore, the Gulf Stream sets close along the reef. He has found the westerly current as

far up as Carysfort, but not frequently, and not broad or strong. This current broadens from Carysfort to the westward, and continues about constant along its course. The tides on the two sides of the reef are about six hours apart, on an average; but set, on the whole, as much one way as the other over the reef. Sometimes there is a narrow easterly current for a mile from the reef; then a westerly current, and then the Gulf Stream. Both the United States steamers Susquehanna and Wabash were set westwardly by the current about eight or ten miles during the past season. A considerable number of the Gulf traders know of the westerly current, and make more or less use of it in navigating westwardly. When running with the wind the water is smooth, and rough when running against it. After northers, the westerly current is to be expected. Sometimes, in crossing to Havana, no Gulf Stream indications are found; and sometimes a westerly current is found along the north shore of Cuba. Notwithstanding Capt. Geiger's long observation of these currents, he says that he is quite unable to reduce them to rule, or in any way to know before hand how the current will be found to set. He asserts that the Gulf Stream sets from the vicinity of Cape St. Antonio, northeasterly through the Florida channel, and that the main stream does not make the circuit of the Gulf of Mexico as generally supposed.

Captain Richardson, pilot of the Coast Survey surveying steamer Corwin, says, in substance, as follows: The westerly current appears irregularly chiefly in the winter, but sometimes during the prevalence of the regular trades. It extends from ten to fifteen miles off from Sand Key, sometimes running as much as two miles an hour. It never prevails over the reef proper. It sets for two months or so some winters. It spreads farther from the reef as it goes west. Has known it as far north as Carysfort, just outside the reef, and at Cape Florida even where the reef is narrow and deep, this current sometimes sets across it some two miles from shore, but is not very frequently found there. As it runs west it seems to increase in breadth. Off Indian Key he has known it to extend seven miles from the edge of the reef; at Bahia Honda it is sometimes ten miles, and at Sand Key, from ten to fifteen miles. In the winter of 1856–7 there was very little of this current. In crossing from Key West to Havana the Gulf Stream runs much stronger on the Cuban side. To some extent, navigators know this westerly current, and use it with great advantage when bound west. In one case in 1852 he knew of two vessels bound east past Tortugas which separated about 100 miles in twenty-four hours, by one captain knowing this current and the channel, while the other kept in the westerly current. The tide between the Quicksands and Tortugas sets flood N.N.E. and ebb S.S.E., differing from the charts.

Captain Wilson who has for several years been running on the vessel serving Fort Jefferson on Tortugas as a mail boat to and from Key West, says that for some three months prior to Feb. 11, 1857, there was a strong and decided westerly current on the north margin of the gulf, on the reef between Key West and Tortugas. It had then for some two months been constantly to the west. Running out from Tortugas on an E.S.E. or S.E. course, and tacking to the north or east of north when the point was reached, which in an ordinary gulf stream would bring him out somewhere from Sand Key light to six or seven miles west of it, which tack if there were no currents would bring him out abreast the Marquesas, he has six times in the last three months come out abreast the Quicksands, thus falling short of where he would have been had the water been still, by some eighteen to twenty miles, or some thirty miles west of Sand Key where he would have fetched during a full Gulf Stream current. It usually takes about twenty hours to run both branches of this tack. There is no appearance of any current on or within the reef either way except the set of the tides. When the westerly current is running, he finds it better to beat up within the reef than to attempt to cross over into the Gulf Stream. Mr. W. thinks the current sometimes extends half way across to Cuba. He says, this westerly current has prevailed more or less, every winter for seven years that he has been running between Key West and the Tortugas; but never so strong as this winter (1857–8), or for so long a time, probably not over a month in any previous case. He thinks the westerly current mainly disappears during the prevalence of the regular summer trades.

I was informed by General Totten that Com. Bainbridge told him, that in a voyage made by him some fifty years since, when he supposed himself in the Gulf Stream, west of Cape Florida, he found by known landmarks that he had drifted a considerable distance to the westward instead of to the eastward.

I am indebted to Mr. Charles Tift, of Key West, for the following notes:—

"In December, 1856 (I think), the barque Joseph Hale from Philadelphia for New Orleans, got ashore ten miles southeast from Cape Florida light-house. She had passed round the 'Isaacs,' and made the Orange Keys, steering for the Double-headed Shot Key's light. While looking out for the light, the ship apparently going seven knots, she struck, and proved to be in the position above stated.

"The ship Rockland from New Orleans to Boston was off the Pan of Matanzas at four o'clock (say March 25th, 1858), wind E.S.E., ship going per compass E.N.E., intending to sight Double-headed Shot Key light. At twelve o'clock saw what was supposed to be the light on Double-headed Shot Keys, and kept the

ship off to pass it on the gulf or western side. But the light proved to be the new one on Sombrero Shoal (just opposite), of which the captain had no notice, and she struck a shoal inside the main reef. A glance at the chart will show how far these captains were mistaken in their estimate of both the force and direction of the current.

"Some years since a fishing smack left Key West to go to Cape Florida. The wind was eastwardly, and after she had beaten to windward for some forty-eight hours, she stood in to make the land. She fetched twenty miles to the westward of the starting point, showing in this instance, a strong westerly current from the centre of the Gulf."

Mr. Tift adds that he "knows that the 'gulf current' sometimes, though rarely, runs strong to the eastward a mile or more *inside* of the reef (at Key West), but that the general set is westward for a *short* distance from the main reef." The idea, however, of a "strong westerly current" on this "edge," must be taken with many grains of allowance. A ship-master leaving the strong gulf current and approaching the margin, finds the set so reduced in its rapidity as to conclude that he has found the stream actually going westward. As stated above, this is only true to a very limited extent, or in other words the belt of westwardly current is very narrow.

I am indebted to Mr. Baldwin, collector at Key West, for a case in his own experience showing a westerly drift, and for some observations made specially valuable by his long and full acquaintance, not only with the matters in question, but with the navigators frequenting Key West.

In June, a few years since, Mr. B. made a passage in a fast-sailing brig from Mexico to Havana. After leaving Campeachy Bank, they made Tortugas Islands and took a departure about sunset, steering about southeast by east. About midnight it fell calm, and for five days they experienced only calms and occasional light airs from the south. On the sixth day there was a light wind from the east. The master, an experienced navigator and well acquainted with those waters, steered south, supposing he had drifted through the Gulf. On the morning of the seventh day he made land, which he supposed was somewhere near Matanzas, but which turned out to be near the Colorados, a reef off the west end of Cuba.

Again, in a voyage from St. Marks to Key West, Mr. Baldwin says, that being set by strong southwest currents in the Bay of Mexico, they fell to leeward and made the Tortugas Islands. Having an experienced pilot they ran through into the gulf between the Tortugas and the Quicksands. After beating to windward for three days they stood in, and found themselves six miles to leeward of where they entered the gulf. Satisfied that

they had to contend with a strong westerly current, the master consented to beat up inside the reef, and they reached Key West in thirty-six hours.

Mr. Baldwin says he has conversed with many intelligent ship-masters, with the Key West pilots, and with the masters of fishing smacks who are constantly crossing and recrossing the gulf to and from Cuba, and says that they assure him that no dependence can be placed on the Gulf Stream; sometimes it runs very much stronger than at other times in a northeast direction: that it very frequently runs in a southwest direction; and that at other times there is no current at all. Very frequently they experience an easterly current on the Cuba coast and the reverse on the Florida coast, and at other times a strong current in the centre. The current cannot be mistaken, as the change is perceptible to the eye.

Mr. Baldwin adds, "A great deal depends on the force of the wind. My own observation has satisfied me that the wind influences the set of the Gulf Stream; for instance, after a heavy northeast wind the stream sets to the northeast at a very rapid rate, and *vice versa.* Since my residence at Key West, I have known several vessels to be brought in from the northwest, having got into the Bay of Mexico, when supposing themselves east of Cape Florida."

He was assured by the master of a vessel from Honduras, and another from Central America, both stranded, that they had come round Cape Antonio, and after beating as they supposed in the gulf, aided by the Gulf Stream for a number of days, discovered land, and judging it to be the Bahamas, shaped their course through the gulf, and were stranded near the Cedar Keys.

These scraps of testimony might be much extended if necessary, but I suppose they fully suffice to show that we are still very far from possessing the knowledge the case demands. They clearly prove that there is enough westerly current in the Gulf of Florida to be of vast importance to navigation if its movements can be defined, and to constitute a great danger, if it is not known. Its variations are also well established, and should be known to navigators. I am also quite well persuaded, not only from actual testimonies, but from the fact that a coral bank extends above Cape Catoche, that at least a large part of the Gulf Stream turns to the northeast around the west end of Cuba, instead of making the circuit of the Gulf of Mexico. The effect of the earth's rotation, and of its own inertia, on the current coming north from the Caribbean Sea, would be to give it an eastward bend. It is also quite incompatible with the tendency of the westerly current to expand towards Tortugas, to suppose that the main Gulf Stream comes sweeping in from near the mouth of the Misissippi towards this point.

Before attempting to theorize on the cause of this westerly current, it is certainly very desirable that it should be more accurately defined. The effect of dragging by the Gulf Stream along its sides, may perhaps be to produce a deficiency of water behind, to be replaced by a return current of this degree of force, but it would certainly not call for such a vast body of westerly current as is vouched for in some cases, nor would it explain its alleged fluctuations. Some of the wrecks which have lately occurred seem due to a strong current setting through the Santarem Channel, and we may see in this a suggestion of a cause for the westward currents when these exceed the magnitude of a proper eddy. A Santarem current projected across the gulf, may be thrown down the reef, though I should not much expect such a result.

It will be well here to call attention to the refutation of the theory that the Gulf Stream owes its progress to a declivity resulting from heaping up waters in the Gulf of Mexico, which this parallel counter current affords. There is no evidence of any such elevation of the Gulf of Mexico as this theory calls for. On the contrary there is no such southeast current across from the Bay of Mexico, Barnes's Sound, &c.,—as such an elevation would inevitably create. The whole motion of a descending river in the sea, with its source in the Gulf of Mexico, seems to me quite untenable and conflicting with facts.

The natural conclusion from what has preceded is, that there is abundant need of further exploration into the movements of this whole system of currents. Their incalculable commercial importance makes such an inquiry any thing but speculative, and should stimulate active and well-conditioned observations. We well know how imperfect the observations by the drift of ships must be; they are rather indications than measurements.

In view of the present state of the case, I would ask attention to the promise of results offered by undertaking an extensive series of current bottle observations; on the line from Cape St. Antonio to Cape Catoche. By systematic proceedings several points might be well illustrated. Suppose a vessel to cross on this line, say twice monthly for a year, throwing over one or two hundred bottles each time, containing slips duly numbered so as to indicate each starting point accurately; these points being regularly distributed on the line run, and checked by the verification of the route sailed. As these bottles proceed on their course, they will become faithful witnesses of the currents, and by their spreading they will show conclusively what the real course of the Gulf Stream is, and whether it is broken, one branch sweeping around the gulf coast, and the other pushing

on northeasterly. With a view to promote their being readily picked up at sea, I would propose that flasks of white glass, blown with broad bases, should be used. These could be seen at a distance, and in a region so crowded with sails as the Gulf of Florida, very many would be picked up while still afloat, thus giving a true measure of mean velocity. A small sailing vessel, such as one of the Key West pilot boats, or the revenue cutter at that station, might, by having a good observer put aboard, make such a course of observations with slight expense in proportion to the results. It is hardly needful that I should here further state the bearings of such a plan, but I think all will concede to it the promise of elucidating some important questions of the Gulf currents. It would surely be much better, could deep sea observations be made also, and to some extent probably they might be connected with a current bottle campaign. The superficial study, ought certainly not to be longer deferred; after this, we can take a next step more wisely.

Art. XXVI.—*Abstract of a Meteorological Journal, kept at Marietta, Ohio:* lat. 39°·25 N. and lon. 4°·28 W. of Washington City; by S. P. Hildreth, M.D.

MONTHS.	Thermometer.							Barometer.		
	Mean temperature.	Maximum.	Minimum.	Fair days.	Cloudy days.	Inches of rain and melted snow.	Prevailing Winds.	Maximum.	Minimum.	Range.
January,	40°·44	67	22	12	19	1·66	w., s.w., & e.	29·93	28·95	0·98
February,	28·00	60	−5	11	17	3·41	w., n.w.	29·75	28·90	0·85
March,	40·70	75	0	21	10	1·00	w., n.w., & s.	29·63	28·95	0·68
April,	54·70	78	26	12	18	5·00	w., s.w., & e.	29·63	28·70	0·93
May,	60·70	84	42	7	24	12·42	s., s.w., & e.	29·65	28·80	0·85
June,	72·70	99	48	20	10	3·09	s., s.w., & s.e.	29·60	29·00	0·60
July,	75·20	95	57	19	12	5·33	s., s.w., & w.	29·63	29·20	0·43
August,	72·13	95	48	19	12	7·42	s., s.w., & w.	29·60	29·15	0·45
September,	64·33	91	38	23	7	1·37	s.w., s., & e.	29·80	29·15	0·65
October,	56·66	85	38	13	18	7·66	s.w., n., & e.	29·80	29·10	0·70
November,	38·80	63	20	3	27	4·82	w., n. w., & s.	29·70	28·85	0·85
December,	40·64	63	14	10	21	8·66	s., s.e., & e.	29·90	29·05	0·85
Year,	53·75			170	195	61·84				

Temperature.—The mean temperature of the year 1858 is 53°·75; more than two degrees above that of 1857, which was 51°·43. The extremes of heat and cold have not been so great as in some years, especially that of cold; the lowest grade of

the thermometer being only five degrees below zero, in February.

Rain and melted snow.—The amount of rain and melted snow is sixty-one inches and eighty-four hundredths, a quantity somewhat exceeding that of any other year since I have kept a register, thirty-two years, and with that kept by Mr. Wood from 1818, making forty years; forty-two inches is the mean amount for a series of years, but in dry periods it sinks sometimes to thirty-two inches, about half that of the past year. The month of May exceeded in quantity that of any other, being nearly twelve and a half inches. It was divided among the seasons as follows: winter $13\frac{73}{100}$ inches, spring $18\frac{42}{100}$ inches, summer $15\frac{84}{100}$ inches, autumn $13\frac{85}{100}$ inches. The quantity of snow was small, four inches being the greatest depth at any one time, not affording sufficient for sleighing.

Winter.—The winter of 1858, was uncommonly mild, the mean being 36°·54; more than six degrees above that of 1857, which was 30°·35; while that of 1856 was 25°·50, the lowest of any one on record. The moderate weather continued until near the middle of February, about which time the Ohio river was open and navigable for steamboats. The mean for December was 41°·20, and that of January 40°·44, being many degrees above that mean for these months, so mild was the weather that it was feared we should have no ice for summer use. The buds of fruit trees swelled as they do in March, and some peach trees on a high sandy ridge of land in Noble county, fifteen or twenty miles north of Marietta, opened their blossoms on the 28th day of January, and what is very curious, notwithstanding the cold in February and March, produced fruit. It was as late as the 18th of February before navigation was closed by ice, and the 24th before the Ohio was frozen over. It remained shut only a few days, and boats were again running by the tenth of March. In a majority of years, the Ohio is closed for a short time in December, but invariably opens again at or near the winter solstice, when there is commonly an abundance of rain. February was a cold month, the mean being 28°·00; whereas in 1857 it was 42°·73, a difference of nearly fifteen degrees. The earlier part of the winter was mild all over the valley of the Ohio.

Spring.—The mean temperature of the spring months is 52°·03; being nearly seven degrees above that of 1857, and a full medium for this climate, the difference being occasioned by the higher temperature of April. The mean of this month is considered as usually representing that of the year, but in 1858 was nearly three degrees above it. The month of May was about the ordinary temperature 60°·70. The early part of March was uncommonly cold, the mercury falling to zero on the seventh of

the month, and for a number of days it was but a little above that point. This severe cold had a disastrous effect on fruit trees of all kinds, especially peaches, apples and pears, the crop of these varieties being entirely destroyed all over the Western States, except in a few favored places, especially in orchards located on the tops of high ridges with a light loamy soil; at this time the blossom buds were red, on the point of opening their flowers. Orchards on islands in the Ohio river were in some measure protected by the proximity of water, and produced a partial crop. The loss to the country must have been more than a million of dollars, as there is scarcely a farmer in the land who has not more or less acres of orcharding, some along the borders of the Ohio raising in ordinary years two or three thousand barrels of apples. Fruit trees blossomed at about their usual period, and when in this state, a severe frost on the 27th of April destroyed the remaining strength of the germs, so entirely that the young fruit all dropped off before it attained the size of a robbin's egg. The grape being later in blossoming, escaped in a measure the ill-effects of frost; but the excessively wet summer rotted and mildewed a large portion of the fruit, disappointing the hopes of the cultivators in affording them only a small crop.

The month of May was excessively wet, raining more or less copiously on seventeen days, summing up at the end of the month the enormous quantity of twelve and a half inches, which is more than all that fell in the spring months of 1857, and a greater amount than ever known before since a register of the rain has been kept. For the three spring months this year the amount was eighteen and a half inches. The effects of this superabundant and constant wet, was very disheartening to the cultivators of the soil. The land could not be plowed at the proper time for the planting of corn and other spring crops, and when it was done, the seed rotted in the earth. Along the margins of the creeks and rivers the bottoms were overflowed, destroying the seeds that had already germinated, and leaving much drift and rubbish, thus marring the grounds for future cultivation. These overflows continued to recur, until as late as the fifteenth of June, and many fields were replanted two or three times, while others were abandoned as hopeless. This excess of rain was not confined to the State of Ohio, but was felt in all the Western States, especially on the river Wabash, where the floods in June were very disastrous. West of the Mississippi river the rains were still more copious, as by a notice in a letter from Lee County, Iowa, there had fallen sixty-five inches from the eighth of April to the first of November, the usual quantity being only forty-four inches; and as December was a very wet month, there was not less than seventy-two inches, or six

feet during the year; an amount usually found only in tropical climates.

Summer.—The mean temperature of the summer months is 73°·34, one degree more than in 1857, and a full average for this region. For the healthy growth of plants there was abundant heat; but the excessive rains so saturated the earth that their roots were in a manner drowned, especially on flat lands, causing a sickly aspect, instead of the usual deep green color seen in common seasons. There was a large proportion of straw in the wheat and oats, but a lack of fullness in the grain; much of the wheat being shriveled and light, a blight or rust having attacked the stems a short time before the harvest, so that in the operation of threshing, a cloud of offensive ill-flavored dust annoyed the workmen, making this labor very irksome. This mould, on the oat crop was still more destructive, causing a total failure in three-fourths of all the fields in the valley of the Ohio; such as escaped were on high grounds and sowed very early. Many fields of wheat were not reaped at all, and left to decay on the grounds, or plowed in for the next crop.

The weather being warm all through the summer and till late in the autumn, gave the Indian corn time to perfect its growth and ripen the grain before the setting in of frosts, thus saving the inhabitants of the west from the disastrous effects of a famine. The grain of this plant, a native of America, is above all others suited to this climate; affording the most nutritious food for man and beast. Potatoes, next to maize as a food for the laboring man, were also a failure. The rot so disastrous in its effects a few years ago to Ireland, destroyed this desirable esculent after it was nearly full grown; and thousands of acres in the southern portions of Ohio, hardly returned the amount of the seed that was planted. Sweet potatoes fared much better, and yielded a fair return to the cultivator. Being a native of a tropical climate, heat and moisture do not injure it if planted on a sandy soil. This year the price of this valuable root was less than that of the common potatoe, when in ordinary years it is double that article. The amount of rain in the summer months was nearly sixteen inches. The maximum heat 99° on the 29th day of June. Although wet summers are accounted to be sickly, yet no epidemic fevers prevailed; it was very healthy.

Autumn.—For the autumnal months the mean temperature is 58°·26, varying but little from that of 1859. During September and October there was no destructive frost, nor until the middle of November, giving late planted corn time to ripen, which it had fully accomplished by the last of October. In ordinary years this crop is ready to be cut by the twentieth of Sep-

tember if planted in due season; all over the uplands of the State it was unusually fine, better on the hills than on the bottoms, as the latter had been too wet for a healthy growth. This abundance of corn furnished the farmers with the means of better fattening their hogs than last year, and the yield of pork is much greater and better in quality. It also bears a fair price, enabling them in some measure, to make up for the loss of their wheat and potatoes. It has been on the whole a disastrous year for the agriculturist, and pecuniary affairs were never more depressed than at present, even more so than in the panic and mercantile failures of 1857, as then he had a fine crop of wheat and abundance of fruit and potatoes to comfort him under his losses.

On the 27th of November there fell seven inches of snow with the temperature at 33°. It rained the following night and in forty-eight hours it was all melted. There has been no ice in the rivers up to this time, 5th of January, 1859, and the greatest degree of cold, the 9th and 10th of December, is 14° above zero.

Floral Calendar.—March 12th, Bluebird seen; 17th, Robbins appear; 20th, Blackbirds in flocks; 25th, Primroses opening, Sugar tree in blow; 29th, Daffodill; 30th, Hepatica triloba, Crown Imperial 12 inches high. April 3d, Crown Imperial open; 4th, Early Hyacinth; 5th, Golden bell or Forsythia virida; 6th, Magnolia conspicua, most of the blossom buds killed in February; 7th, Peach tree, in sheltered localities; 9th, Pear tree opening; 10th, Sanguinaria Canadensis, Pyrus Japonica, a few blossoms, much injured by the cold 23d Feb.; 11th, Pear in bloom; 12th, Spiræa prunifolia, blooms sparingly, much killed by the cold, Double flowering peach, very fine, more hardy than the common; 13th, Cercis Canadensis, or red bud; 14th, Plum and Cherry; 15th, Cucullaria spectabilis; 17th, Apple in full bloom; 18th, Jeffersonia diphylla; 21st, Dwarf Ranunculus Triphyllum uliginosum; 24th, Lilac; 26th, Cornus Florida; 29th, Quercus tinctoria, black oak; 80th, Garden tulip and tree Peony. May 3d, Viburnum dentatum, black Haw; 8th, Prunus scrotina, black Cherry, Cratægus flava, summer Haw, Shell-bark hickory, Aquiliegia Canadensis, Columbine; 9th, Geranium maculatum; 13th, Robinia pseudoacacia, yellow Locust, Dodecatheon Illinoisi, or Prairie Captain, Calceolaria, white and yellow varieties; 13th, Weigelia rosea; 18th, Magnolia tripetala, Castanea equinus, Horse chestnut, Rubus villosus, Blackberry, bore an enormous crop of fruit, more than ever known before; 19th, yellow Harrison rose; 20th, Black mulberry; 22d, Purple peony; 23d, Syringa fragrans. June 2d, Euonymus atropurpurea, wahoos; 3d, Syringa Philadelphica; 4th, Trades-

canthia virginica, Spiderwort; 5th, Rosa Carolina, swamp rose; 8th, Sambucus Canadensis, Elder; 11th, Vitis cordifolia, frost grape; 12th, Rosa multiflora, prariensis; 13th, Triosteum perfoliatum, feverwort, Rhus typhina, sumach; 25th, Wheat harvest begins in warm exposures; 28th, Asclepias cornuti, milkweed. July 6th, Lobelia spicata; 15th, Rhus radicans, trumpet creeper; 16th, June-eating apple ripe; 17th, Sweet bough apple; 18th, Blackberry ripe; 26th, Cassia Marylandica, wild senna, in flower. August 11th, Watermelon ripe in open fields; 19th, Sweet potatoe in market, good size.

Marietta, Ohio, January 5th, 1859.

Art. XXVII.—*Remarks on the Lower Cretaceous beds of Kansas and Nebraska;* by F. B. Meek and F. V. Hayden.

(Extracted from the Proceedings Acad. Nat. Sci., Philad., Dec., 1858, with additions by the authors.)

The Cretaceous System as developed in Nebraska, is clearly divisible into five distinct formations, which have, for convenience, been numbered 1, 2, 3, &c., from the base upwards. Although at first entertaining some doubts as to whether No. 1, or the lowest formation, might not be older than Cretaceous, we always placed it provisionally, in our published sections, in the Cretaceous system. More recently, after a careful review of the subject, we became satisfied from the modern affinities of numerous dicotyledonous leaves found in this formation, that we hazarded little in regarding it as a settled question that it could not be older than Cretaceous, and so expressed ourselves in our paper read before the Academy of Natural Science, Philadelphia, March, 1858.

The references of this formation to the Cretaceous, however, was not without some exceptions generally admitted, for Professor Jules Marcou, in his work on the "Geology of North America," page 143, refers it to the New Red Sandstone, and in a subsequent publication* he places it in the Jurassic; while some investigators in this country also, inclined to the opinion that it must be Triassic. In the midst of these conflicting opinions, although satisfied we were right, we wished, in order to remove all doubts from the minds of others, to have the opinion of some good authority in fossil botany, (a department of palæontology to which we have given little attention,) respecting the fossil leaves on which we mainly based our views in regard to the age

* Notes pour servir a une description geologique des Montagnes Rocheuses, p. 20.

of this formation. Consequently, we sent outline sketches of a few of them to Professor Oswald Heer,* the distinguished authority in fossil botany at Zurich, Switzerland, informing him they were from a formation we regarded as Cretaceous, and requesting him to let us know to what genera and geological epoch he would refer them. This letter was sent to Professor Heer in August last, before we started to Kansas, and on our return, in the latter part of October, we were disappointed at finding no reply from him. After waiting some days longer, and receiving no answer from Professor Heer, we concluded our letter had either failed to reach him, or that he was unwilling to express an opinion based upon mere sketches of the leaves; consequently we submitted the whole to Dr. Newberry, who had then returned to Washington, and in whose opinions on this subject we have the fullest confidence.

After examining the specimens, Dr. Newberry gave us a written statement bearing date, Nov. 12, containing a list of the genera to which he had referred the leaves, together with some interesting remarks and generalizations, in which he expressed the opinion that they are certainly Cretaceous, some of them belonging to genera peculiar to that epoch, and that the whole belong to more highly organized plants than are known in the Triassic or Jurassic flora.

Knowing as we did that the rock from which these plants were obtained, beyond all doubt, holds a position beneath, at least, eight hundred feet of Cretaceous strata, containing great numbers of *Ammonites*, *Scpahites*, *Baculites*, &c., it of course never once occurred to us that any person might suppose it Tertiary.

About the thirteenth of November we sent on to the American Journal of Science, a communication containing Dr. Newberry's list of the genera to which he had referred these plants, with some extracts from his remarks, all of which appeared in the January number of that Journal.† Some two or three weeks after we had corrected the last proof of this paper, we received (13th of Dec.) a letter from Professor Heer, bearing date of Nov. 26, in which he informed us that our letter had reached him at a late date, in consequence of his absence from home, and that after his return, other engagements had prevented him from replying sooner. In this letter Professor Heer, in accordance with our request, sent us a list of the genera, as near as it was possible for him to make them out from hastily drawn sketches, and also kindly furnished brief diagnoses of the species, stating at the same time that although one of the outlines resembles a

* Our friend Dr. Newberry was then in New Mexico.
† These were published in the last number of this Journal.

Cretaceous genus (Credneria,) the nervation being obscure, and the others more like Tertiary forms than anything known in the Cretaceous of the old world, he was inclined to the opinion that they are Tertiary.

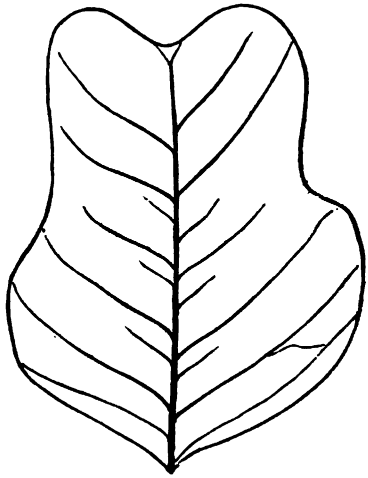
Along with Professor Heer's letter, we also received a printed pamphlet, entitled "*Letters on some points of the Geology of Texas, New Mexico, Kansas and Nebraska; addressed to Messrs. F. B. Meek and F. V. Hayden, by Jules Marcou.*" In this pamphlet Professor Marcou quotes Professor Heer's conclusions in regard to our fossil plants, and expresses the opinion that No. 1, of the Nebraska section, is both Miocene and Jurassic, or in other words, that we have included in it strata belonging to each of these two widely different geological epochs.

Having a very high regard for Professor Heer's opinions on any question in fossil botany, where he has had an opportunity to examine the specimens themselves, or to study good figures and descriptions, we are quite sure, had the whole collection been submitted to him, instead of mere sketches of a few of the species, his opinion would have been very different. At any rate we can assert, with the fullest confidence, that it is absolutely *impossible* that this formation, or any part of it, can be Tertiary, for we know it passes, as already stated, beneath at least eight hundred feet of Cretaceous strata. This is not mere conjecture, nor an inference drawn from having seen this formation under circumstances leading us to *suppose* from the dip of the strata, that it must pass beneath the Cretaceous if continued in a given direction at the same angle of inclination, but from the fact that it has actually been seen, directly beneath the other Cretaceous rocks, not merely at one place, and by one observer, but by several persons at numerous localities.

In order to satisfy others that we are not mistaken in this, we will give a few of the many facts in our possession, bearing on this question. In the first place, we would remark that the farthest point towards the south at which we have seen this formation, is near Smoky Hill river, in Kansas, latitude 38° 30′ north, and longitude 97° 30′ west. Here we found it forming the upper part of several isolated elevations known as the "Smoky Hills," at an altitude of about 1200 feet above the Missouri at Fort Leavenworth. At this locality, however, we saw no rocks overlying it, and consequently have no *stratigraphical* evidence that it is the same rock seen by us at other localities under Cretaceous beds; but our lithological and palæontological evidence is quite conclusive on this point, for this rock in color, composition, and all other respects, is undistinguishable from No. 1, of the Nebraska section, as seen near the mouth of Big Sioux river on the Missouri, and contains numerous fossil leaves, some of which are identical with those occurring in No. 1, at the last

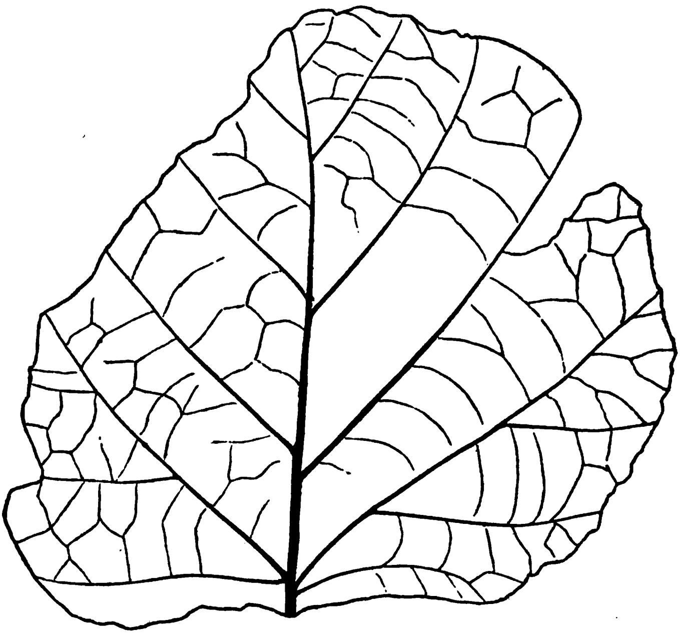
mentioned localities. Amongst these leaves Dr. Newberry has also identified at least one genus (*Ettingshausinia*, No. 3 of the following cuts,) peculiar to the Cretaceous System. The specimens from which this outline was drawn, was not in our possession at the time we sent the outlines to Professor Heer, but was afterwards found associated with several of the species from which the sketches sent him were drawn. The annexed cuts, Nos. 1 and 2, represent other forms from the same rock.

1.

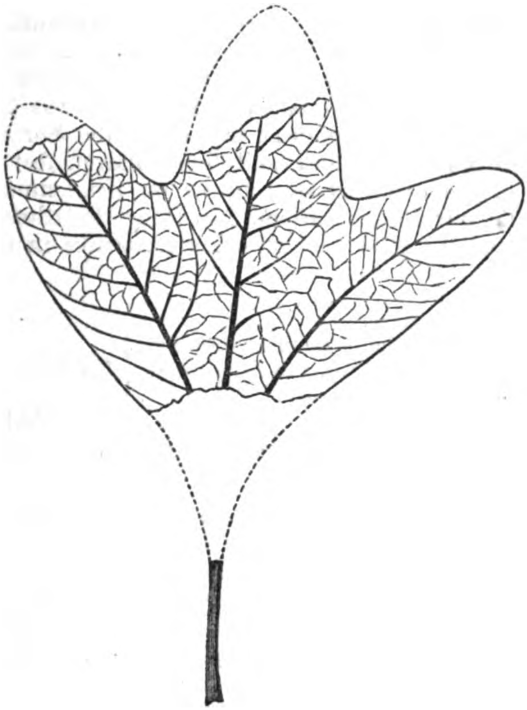


Bearing in mind that all the rocks here have a gentle but uniform inclination or dip to the northwest; and that the formation under consideration consists of red, yellowish, and other colored sandstones and clays, with generally more or less impure lignite and ferruginous concretions, we will be prepared to recognize it at lower and lower elevations as we proceed northward.

2.



3.



Without undertaking to mention in detail all the intermediate places where this rock is known to occur, we pass at once to localities where it has been observed by various persons *beneath* Cretaceous beds. First at several points on the Republican fork of Kansas river, about eighty miles above its mouth, and some sixty miles nearly due north of the Smoky Hills, it was seen by Dr. H. Englemann at an elevation of about 1000 feet above the Missouri, at Fort Leavenworth. Here Dr. Englemann describes it as "a coarse grained, friable dark brown ferruginous sandstone, and very compact white and light colored shaly sandstone."

Near this locality he saw it *overlaid* by Cretaceous beds, the section given by him being as follows descending. "The top was formed of a white granular limestone, and another more impure yellowish variety *full of Inoceramus.* Below there seemed to be a sandy clay, probably from decomposition of arenaceous and argillaceous slates, and then a stratum of gray compact subcrystalline limestone in thin layers, *full of Inoceramus Cripsii.*

In the lower part of the hill the ferruginous sandstone was exposed." Report Sec'y War, Dec. 5, 1857, p. 497.

Again it has been seen by several observers at different times near Little Blue river, not far from the Kansas and Nebraska line,—lat. 40° and a little west of the 97° of west longitude. Here at an elevation of about 700 feet above the Missouri at Leavenworth, or three hundred feet below the horizon of the localities on Republican fork, and, five hundred feet below the elevation of the outcrops seen by us on the summits of the Smoky Hills, our deceased friend, Mr. Henry Pratthen, saw near Wyeth's creek, in 1853, the following exposures in descending order:

1. Slope, height not given.	
2. Yellow and whitish limestone filled with casts of *Inoceramus*, referred by him to *I. myteloides* =*I. problematicus*.	No. 3, Nebraska Sec.
3. Slope, thickness not given.	No. 2, Nebraska Sec.
4. Red ferruginous sandstone *with leaves of dicotyledonous tress.*	No. 1, Nebraska Sec.

A short distance west of this exposure Dr. J. G. Cooper informs us he saw outcrops of a red sandstone in the valleys at about the same elevation; and above this, exposures of dark gray laminated clay answering exactly to the description of No. 2, of the Nebraska section, while above the latter, near the tops of the hills, he met with outcrops of *light colored limestone containing numerous casts of Inoceramus.*

At other localities not far to the southwest of the foregoing, Mr. Hawn saw exposures of *light colored limestone* forty-five feet in thickness, *containing great numbers of Inoceramus* which we referred, from specimens sent by him, to *I. problematicus.** Below this there was a slope of twenty-seven feet in which he saw no exposures, while still lower he observed outcrops of *dark ferruginous and yellow sandstone, and various colored clays with impressions of leaves*, resembling, as he supposed, those of oaks and willows. (See his section published by us in the Proccedings of the Academy of Natural Sciences of Philadelphia, May, 1857.)

Proceeding northward from the last mentioned localities, we find on reaching the Loup fork of Platte river, near the eastern limits of the Pawnee reservation, outcrops of the light colored *Inoceramus* beds already mentioned, (No. 3, Nebraska section,) near the water's edge; and at the mouth of Loup fork, on the

* We have referred this species to *I. problematicus* with some doubt; it is the same species inscribed by Dr. Schiel in the second volume of the Pacific Rail Road Report, page 108, plate 3, figure 8. It is rather longer on the hinge than is common in *I. problematicus*, from which it may be distinct. We always refer to this shell in speaking of *I. problematicus*, in this paper.

Platte, the red sandstone No. 1, so often referred to, crops out near the river margin, *while the Inoceramus beds are seen in the bluffs above it.* Going down the Platte in a direction nearly contrary to the dip of the strata, we find this sandstone rising up so as to form near the mouth of Elk Horn river, bluffs some sixty feet in height. Here it seems to rest directly upon upper Carboniferous rocks. Continuing on down the Platte, we find this red and yellow sandstone rising higher and higher in the hills until we come within five or six miles of the Missouri, where it is seen with its base elevated near sixty feet above the Platte; and there are probably outliers of it between that point and the Missouri at greater elevations. So that we find the same formation which at the Smoky Hills, is elevated twelve hundred feet, —on the Republican river, one thousand feet,—and near Little Blue river seven hundred feet, above the Missouri at Leavenworth, has by the gradual northwestern dip of the strata, sunk to within about one hundred feet of the Missouri at the mouth of the Platte.*

Ascending the Missouri from the localities just mentioned, we see occasional exposures of the upper Carboniferous rocks, which gradually sink lower and lower until they pass beneath the river near Florence, to be succeeded by the reddish and yellow sandstones, &c., of No. 1.—(Nebraska section.) At localities along the river above this, occasional exposures of this formation are seen with its characteristic fossil leaves; and at several points, some thirty miles below the mouth of Big Sioux river, it forms perpendicular escarpments of yellowish sandstone rising from the water's edge to an elevation of about eighty feet; while at higher points, back on the summits of the hills, *the same calcareous beds are seen, containing Inoceramus problematicus.* Here at a quarry in the sandstone (formation No. 1,) some twenty feet above the level of the river, one of us (Dr. H.) collected a large number of fossil leaves, some of which are identical with species found by us in this rock at the Smoky Hill locality already mentioned. The sketches of leaves sent by us to Prof. Heer were mostly drawn from specimens collected at this locality.

At the mouth of Big Sioux river a low bluff of this formation, not more than fifteen or twenty feet in height, is seen, and on the hills back a little from the river, at a higher elevation, the same *Inoceramus* bed crops out at several places, and is used for

* The gradual descent of the Missouri river makes its surface at Fort Leavenworth, about three hundred feet lower than at the mouth of the Platte, hence the exposures of No. 1, seen at the latter locality, near one hundred feet above the Missouri, are some four hundred feet above the level of the Missouri at Fort Leavenworth, and of course about three hundred feet lower than the Little Blue river outcrops. The dip however, is greater than this would indicate, for the strata incline towards the northwest, while the mouth of Platte river, is northeast of the Blue river localities.

making lime. At another locality about eight or ten miles up the Big Sioux river, which comes in from the northwest, one of us (Dr. H.) saw No. 1, containing its characteristic fossil leaves, *directly beneath* No. 2, of the Nebraska section. The exposure presented the following beds in the descending order:

1. 20 feet exposed of light gray limestone and marl, containing *Inoceramus problematicus.*	No. 3, Nebraska Sec.
2. 45 feet dark laminated clay with ferruginous concretions containing fish scales.	No. 2, Nebraska Sec.
3. 15 feet exposed above the edge of the water, consisting of yellowish friable sandstone, with a thin bed of impure lignite above, and some layers of various colored clay below, containing *dicotyledonous leaves.*	No. 1, Nebraska Sec.

One of the sketches of a long lanceolate leaf, like some of the existing species of Salix, sent by us to Prof. Heer, was drawn from a specimen collected from one of the lower sandstones here.

Again at another locality on the Missouri, about thirty miles above the mouth of Big Sioux river, No. 1, was seen by one of us (Dr. H.) only five feet above the water's edge, and *immediately overlaid* by No. 2, of the Nebraska section, containing its characteristic species of *Ammonites;* and directly over the latter, he saw No. 3, containing *Inoceramus problematicus.** At this locality he also found in No. 1 some of the same fossil leaves that characterize it at the other places already mentioned.

On ascending the Missouri, above the last named locality, formations No. 2, 3, 4 and 5 are seen to sink at the same gradual uniform rate of dip, in regular succession, beneath the level of the river; so that on reaching Heart river, we find the top of No. 5 nearly down on a level with the water's edge, and a short distance above that locality, it passes out of sight to be succeeded by the Great Tertiary Lignite basin of the upper Missouri, which overlaps it on the hills along the river for some distance below.

From the foregoing statement, we think it will be clearly understood, that formation No. 1 of the Nebraska section holds a position *beneath* the other cretaceous deposits of that region; while the occurrence in it of the remains of highly organized angiosperm dicotyledonous plants proves that it cannot be older than Cretaceous. It may be argued, however, that it may in part be Cretaceous and part Tertiary, or at any rate that *some* of these leaves may have been obtained from overlying Tertiary beds which we have confounded with the Cretaceous below.

* It is of course unnecessary for us to inform geological readers that a rock overlaid by strata containing *Ammonites* and *Inoceramus,* cannot be Tertiary because these genera became extinct at the dawn of the Tertiary epoch.

This, however, is impossible, simply because specimens of nearly all the species found at the various localities have been quarried from the same bed at Blackbird Hill, and the whole,—not a part only—of this formation, passes beneath all the other Cretaceous rocks of the northwest. In addition to this, we have extensive collections of plants from the Tertiary of Nebraska, not a single species of which is identical with those from No. 1.

When we stated in some of our papers that it was possible we might have included in this formation beds not belonging to the Cretaceous, it was not because we thought any part of it might be Tertiary, but because we suspected some of the lower beds referred to it in Kansas might possibly be Jurassic; and we are even now prepared to believe that it may yet be found to repose on Jurassic rocks in that Territory, as it does at the Black Hills, in Nebraska.

Art. XXVIII.—*Geographical Notices.* No. VI.

Semenow's Explorations in Central Asia, 1857.—The trigonometrical survey of India, the exploring expedition of the Brothers Schlagintweit, and the researches of Russian travellers are making valuable contributions to our knowledge of Central Asia. In a recent number of Petermann's journal a highly important paper is presented in respect to the expedition of P. V. Semenow, in the neighborhood of the Balkasch lake. The article is based upon original data furnished by the traveller, and dated St. Petersburg, June, 1858.

We condense and translate such portions of the article as are most interesting, regretting that we are not able to transfer it entire.

To the south of the Russo-Siberian frontier and military post route, which follows the course of the Irtysh, there extends a wide and sterile tract, universally known as the Kirghese Steppe. This Steppe has a rocky substratum mostly crystalline, but in part also sedimentary, swelling into hills and occasionally aggregated into small and low mountain-clusters. Its characteristic features are aridity, the absence of trees, scarcity of streams, relatively insignificant height of the hills which hardly in a single instance deserve the name of mountains, and numerous salt-deserts with their accompanying halophytes (salt water plants).

But as we arrive at the river Ajagus, an eastern tributary of the Balkhash Lake, and pass beyond the low sandy downs, that by their depression, their saline character, and their numerous standing pools bordered with sedges, indicate a former connection between the Balkhash and the Ala-kul, we enter an entirely

different region. This long low mostly dry bed of what must formerly have been one continuous lake extending from the 74th to the 82d meridian east of Greenwich, forms a marked dividing line between the mountain-systems and general physical features of Central Asia on the south, and Siberia on the north. From this line onward we encounter a continuous series of magnificent Alp-lands, rising height above height till they at last blend with the Thian-schan, the most central of the mountain ranges of Asia. This line too forms a natural limit, north of which we no longer find many of the vegetable growths or the animals of Central Asia, such for instance as the *Populus diversifolia* and the *Pyrus Sieversiana* among trees, or the tiger, the hedgehog, the pheasant, &c., among animals.

Semenow's explorations, made in the year 1857, relate mostly to this Central Asiatic Alp-land, which though comparatively small in extent, is yet charming for the variety of its scenery, and attractive to the physical geographer for its union of so many different zones with their diverse characteristics of soil, of temperature, of vegetable and animal species, etc. It is bounded on the north as we have stated by the Balkasch-Ala-kul Lake belt, on the east by the snow-covered crest of the Dzungarisch Ala-tau, and on the south by the perpetual snows and glaciers of the Thian-schan, and it comprises all altitudes between the wide extremes of 600 and 2000 Paris feet.* This region, in addition to its interest for natural science, is also attractive to the ethnographer, as having been from the earliest times one of the most important stations for those vast wandering hordes which have successively overrun Europe. For here in the broad and fertile valley of the Ili they would often stop for several years, and then with the fresh strength and energy gained by their repose, take up their march around the southern shore of the Balkhasch, either northwest toward Europe, or southwest towards Turan, Southern and Western Asia.

The Ili divides this portion of Central Asia into two parts, the northern called "the land of seven rivers," the southern "the land across the Ili," (Transilian,) names given them by the early Russian settlers.

The distinctive features of this region are its three lofty Alp-lands, viz.:

1. The Dzungarisch Ala-tau, (closely connected with the Talki-chain that divides the Ala-kul and the Ili valleys,) with a medium ridge altitude of 6,000 feet, and a peak altitude of 12,000 feet.

2. "The Ala-tau across the Ili," between the Ili valley and the Issyk-kul plateau, with a medium ridge altitude of 8000 feet, and a peak altitude of not far from 14,000 to 15,000 feet; and

* Semenow's measurements are all given in Paris feet.

3. The Thian-schan, between the Issyk-kul plateau and the plains of Little Bucharest, with a medium ridge altitude of about 11,000 feet, and a peak altitude of perhaps 20,000 feet. The Dzungarish Ala-tau on its western slope and the Transilian Ala-tau on its northern face decline directly into a broad Steppe-level that stretches away at the varying elevation of 1500 to 500 feet to the Balkasch basin, and comprises the entire western and northwestern portion of this region. And the nearer we approach to the Balkasch, the more flat, arid, unfruitful, sandy and saline does the soil appear, gradually becoming covered with the *Haloxylon ammodendron* and with halophytes; and the streams, which as they issued from the mountains were bright, clear and rapid, become more sluggish and turbid till at last they come to a stand amidst sandy downs and sedgy marshes, and but three of them, viz.: the Lepsa, the Karatal, and the Ili actually reach the Balkasch Lake.

But the transition zone between the mountain-land and this Steppe, is on the contrary, one of the finest agricultural tracts on the continent. It possesses a deep vegetable mould, a luxurious growth and such an abundance of water that the inhabitants, the Kirghese, the Buruti and the Russian Cossacks, apply an artificial irrigation to their fields with surprising facility.

If we now take a general survey of this region in its practical adaptations to the wants of its inhabitants we shall find that it includes four natural zones, each offering its peculiar tribute to the general welfare. 1. The Steppe-zone, 500 to 1500 and in some places 2,000 feet above sea-level, affords most excellent winter quarters for the Nomads, on account of its mild climate and its almost entire exemption from snow. 2. The agricultural zone, from 1,500 to 4,000 feet of altitude, contains rich arable lands. 3. The pine-tree zone, from 4,000 to 7,000 feet in altitude, yields abundance of timber wood for building; and 4, the Alpine meadow zone, from 7,600 to 9,000 feet in altitude, entices the Nomads by its wholesome air and its rich pasturage to resort thither during the summer. There are two other zones, viz.: the High-Alp and glacier-zone from 9,000 to 11,200 feet in altitude, with its brilliant flora, and the snow-zone, or the region of perpetual snow; but these will forever remain practically of no immediate importance to colonists.

We omit Semenow's measurements and notes, geological, physical and enthusiastically descriptive, taken during his explorations in the Dzungarisch Ala-tau and the Thian Schan, and give briefly the results of his observations upon the Issyk-kul lake. Between the Transilian Ala-tau and the Thian-schan ranges there is a plateau of 4,200 feet altitude, 230 wersts in length, and 70 in breadth, in which the charming lake of Issyk-kul is situated. This lake is 150 wersts in its extreme length by

50 wersts in breadth. Its waters are brackish and unpalatable. It is fed by over 40 short mountain streams, which fertilize the otherwise sterile soil of the plateau, and which are fringed by long lines of trees. But little sedge is to be met with, and that only around the indentations of the lake. On the contrary, the *Hippophae rhamnoides* forms a thick bushy growth in the neighborhood of the shore. Between the mountains and the lake there is a belt of from 7 to 20 wersts in breadth. At one point only do we find the case otherwise, viz.: the Kesse Tsengyr on the northern shore, where a spur from the Ala-tau approaches so near the water that there is merely room enough left for a waggon road. The immediate border of the lake is in general low and sandy; but around some of the bights the land is more elevated and presents a steep descent to the water; in such places the beating of the waves frequently wears away the loose alluvial strata of which these bluffs consist, so that large masses will at intervals crumble into the lake. Semenow saw no islands in the Issyk-kul. From the fact that so many streams flow into it, he conjectured that it must at some point effect an outlet. Geographers had hitherto represented the river Tschu as such an outlet, but Semenow followed the Tschu up toward its source and ascertained that it approached the lake no nearer than 5 wersts. Here it breaks through a frightful gorge in the Byam mountain, a continuation of the Transilian Ala-tau, and flows N.E. to unite with the Kebin. If the waters of the Issyk-kul had at some previous period been about two hundred feet higher than they now are, (and there are water-marks near the base of the mountain which may warrant such a supposition,) then the lake may itself have opened the Byam gorge, and so discharged its surplus flood into the Tschu. Such a former high state of its waters will account for the frequent conglomerate strata on its banks, which were doubtless formed in the lake-bed, and brought to view on the recession of the waters. Semenow found moreover an additional argument for this hypothesis in a legend of the Buruti that the ruins of a submerged city are at certain seasons visible at the mouth of the Tub, and under the surface of the water. In fine his explorations led him to conclude that if it were not for the existence of the Byam gorge, there is no good reason why the Issyk-kul might not rise not merely 200 feet but many hundred feet above its present level.

It only remains for us now to speak of the temperature of the Issyk-kul plateau. Near Viernoie, the second Russian settlement on the military road to the Transilian Ala-tau, and directly to the north of these mountains, the ground is commonly covered with snow only in January and February. In the Issyk-kul plateau snow lies on the ground for over four months of the winter season. In the beginning of May when at Viernoie,

apricot and apple trees are in blossom, at Issyk-kul it freezes after sundown, and the use of furs is indispensable. Still we are surprised to learn that notwithstanding the elevation of the Issyk-kul it is never frozen, although some of its smaller bays are sometimes encrusted with thick ice. This fact is doubtless to be attributed to the temperature of the deep bed of the lake.

The Glaciers of the Tengri-Tagh.—The Tengri-Tagh, a colossal mountain range directly to the east of the Thian-schan, and whose loftiest peak, the Tengri-Khan, soars to a height, as estimated by Semenow, of 20,000 feet, exhibits on its northern declivities a series of glacier formations that are not surpassed in their dimensions by those of the Alps. Semenow informs us that he had hitherto doubted whether true Alpine glaciers could exist in such a dry climate as that of Central Asia. But the most essential features of their formation, viz.: an enormous accumulation of perpetual snow, and basin-like depressions towards the inner termini of the high mountain valleys, were here, and he could doubt no longer when his further explorations were at last "rewarded with the view of three Alpine glaciers and a vast glacier sea." "The valleys into which the glaciers of the Tengri flow are so flat and broad, and their slope is so inconsiderable, that the plastic ice can more readily expand on all sides into glacier seas, than move forward and downward." The Tengri glaciers differ from the Alpine in two respects, viz.: in the absolute level of their upper and lower termini, and in their color. The latter are sometimes found to reach a point 5,500 feet below the snow-line, while 2000 feet appears to be the utmost vertical extent of the former. And may not this lesser range of absolute level in the Tengri glaciers, joined to their lesser slope, permit the snow-light the more readily to stream through them, thus accounting for their water-green color, so different from the delicate blue that marks the glaciers of the Alps?

Trigonometrical Survey of India. Measurement of Himalayan Peaks.—In the last number of this Journal, it was mentioned that a third peak higher than the once preëminent Dhaulagiri had been measured near the Karakorum pass in the Kuen Luen Mountains. The information was communicated to the Royal Geographical Society of London, Nov. 23, 1857, and briefly reported in the Athenæum. The measurement (giving a height of 27,928 feet) was made by Messrs. Montgomerie and Elliott Brownlow under the direction of Col. Waugh.

Various inquiries having been made of us in respect to the measurement of the peaks in Central Asia, we give in this connection the data reported by Col. Waugh, to the East India

Company, concerning the measurement of the four famous peaks of the Himalayas.*

Name of the Peak.	Station of Observation.	North latitude.			Longitude East from Greenwich.			Height above sea level in English feet.
Choomalari or I.	Senchal, H. S.† ..	27°	49′	41,5″	89°	18′	43,1″	23,946
	Tonglo, H. S. ...	"	"	41,5	"	"	43,1	" 41
	Mean,..	27	49	41,5	89	18	43,1	23,946
Kinchinjunga or IX.	Doom Dangi, T. S.	27	42	9,5	88	11	26,4	28,151
	Senchal, H. S. ...	"	"	9,3	"	"	26,2	" 50
	Birch, H. S.	"	"	9,4	"	"	26,2	" 63
	Thakoorganj, T. S.	"	"	9,8	"	"	26,7	" 47
	Tonglo, H. S.	"	"	9,3	"	"	26,2	" 80
	Bunderjoola, T. S.	"	"	9,2	"	"	26,1	" 42
	Menai, T. S.	"	"	9,2	"	"	26,3	" 72
	Baisi, T. S.	"	"	9,6	"	"	26,3	" 60
	Harpoor, H. S. ...	"	"	9,5	"	"	26,3	" 40
	Mean,..	27	42	9,4	88	11	26,3	28,156
Mount Everest or XV.	Doom Dangi, T. S.	27	59	16,5	86	58	5,8	—
	Menai, T. S.	"	"	17,1	"	"	6,1	28,990
	Harpoor, T. S. ...	"	"	16,5	"	"	5,7	9,026
	Ladnia, T. S......	"	"	16,7	"	"	5,8	8,999
	Janjpati, T. S.....	"	"	16,7	"	"	6,0	9,002
	Miriapoor, T. S. ..	"	"	17,0	"	"	5,8	9,005
	Lirol, T. S.	"	"	16,7	"	"	5,8	8,992
	Mean,..	27	59	16,7	86	58	5,9	29,002
Dhaulagiri or XLII.	Ramnagar, T. S...	28	41	47,9	83	32	8,8	—
	Morairi, T. S.	"	"	48,1	"	"	8,3	26,815
	Banarsi, T. S.	"	"	48,1	"	"	8,7	" 00
	Slaonbarsa, T. S. .	"	"	47,8	"	"	8,9	" 60
	Poovenah, T. S. ..	"	"	47,8	"	"	8,9	" 43
	Ghaos, T. S.	"	"	48,2	"	"	8,2	" 06
	Toolsipoor, T. S...	"	"	48,2	"	"	8,4	" 01
	Anarkali, T. S. ...	"	"	47,8	"	"	8,8	" 00
	Mean,..	28	41	48,0	83	32	8,6	26,826

We also give the following general account of the progress of the Trigonometrical Survey of India, from the annual address of Sir R. I. Murchison, in 1858, as president of the Royal Geographical Society.

"The trigonometrical survey of India was commenced by Colonel Lambton in 1803, and continued by him till his death in January, 1823. During that period he measured an arc of

* v. Peterm. Mittheil. 1856, p. 380.

† H. S. signifies Hill Station, and T. S. Tower Station.

the meridian from Punnae in 8° 9′ 35″ near Cape Comorin to Damargidda in lat. 18° 3′ 16″, being about ten degrees of latitude, and extended a net of triangles over the south part of the peninsula of India, reaching on the east side of the principal meridian to the 19th parallel. Colonel Everest, who had been his chief assistant since 1817, and succeeded him at his death, completed the section commenced by Lambton, and extended the arc to Seronj, lat. 24°, near which place he measured a base of verification. This is the most important base in the trigonometrical survey of India, as all the work to the north, east, and west is dependent upon it. Colonel Everest carried on the measurement of the meridional arc to its completion in the Dehra Dún, lat. 30° 19′; the whole extent from Cape Comorin being 22½° of latitude. He also extended a longitudinal series from the Seronj base to Calcutta, in the neighborhood of which he measured a base of verification. From points selected on this series originate distinct sects of meridional series, the northern limits of which are united by a longitudinal series running along the foot of the great mountain chain, which thus completes the triangulation of that vast tract, comprising about 223,000 square miles.

"When this distinguished officer left India, Colonel, then Captain Waugh, who had been his chief assistant since 1832, was appointed his successor in December, 1843, and following up the admirable plan of survey laid down by his predecessor, the principles and methods of which have been described by Everest,* he worked out the several series left unfinished between the meridional arc and that of Calcutta. Finally he measured a base of verification at Sonakoda, lat. 25° 18′, long. 88° 18′, and also completed the triangulation of the south coast series from Calcutta to Ganjam.

"Colonel Waugh then commenced operations on the west of the great meridional arc, and measured a longitudinal series from the base of Seronj, passing through Rajputana and the sandy desert to Karachi, upwards of 700 miles in extent, where a base of verification was measured, whilst the triangulation of the Bombay meridian was connected with this series. He further extended another series in a northwest direction from the stations of the meridional arc, Banog and Amsot, through the plains of the Panjab and a great portion of the mountainous tract to Peshawar. Again, a base of verification was measured near Attock, the series embracing an area of about 67,000 square miles. A meridional series is far advanced from the base at Karachi, along the Indus, to that near Attock. This operation will complete a gigantic geodetical quadrilateral, of

* Account of the Measurement of the Arc of India, 2 vols., 4to, 1847.

which the great arc series forms the eastern side. Simultaneously with these trigonometrical operations, most minute and elaborate topographical surveys have been executed under the superintendence of Colonel Waugh throughout the greater portion of these tracts.

"Lastly, having determined that of all the mountains whence the affluents of the Ganges run, the loftiest summit is situated about midway along the Himalayan chain, and finding that this culminating point (N. lat. 27° 56′, E. long. 86° 53′) was 29,002 English feet above the sea, and consequently 846 feet loftier than the famous Kinchinjunga of Nipal, Colonel Waugh has gratefully and appropriately named this, the highest known elevation in the world, Mount Everest, after his valued geographical instructor."

CENTRAL AFRICA. EXPEDITIONS OF CAPT. BURTON AND DR. ROSCHER.—Our readers are already acquainted with the expedition of Capt. Burton, and of his determination to reach, if possible, the mysterious lake of Central Africa, by penetrating westward from the coast of Zanzibar. Letters received from Rev. J. Rebmann, missionary at Zanzibar, by the Church Miss. Soc. of London, and published in their Record for December last, state that Capt. Burton had reached the lake Uniamesi, but give no further particulars in respect to his journey. Three letters from the explorer himself giving his observations in Zanzibar, written in a spirited style, are given in Blackwood's Magazine for February, March and May, 1858.

The missionary letters just alluded to, announce also the arrival in Zanzibar of the German traveler, Dr. Albrecht Roscher, and of his departure for the reported snow peaks near the equator. Dr. Roscher is represented as qualified in every way, by his previous studies, his energy of character and his excellent outfit, to undertake this difficult exploration. He proceeds under the patronage of the king of Bavaria. From his efforts and those of Burton, we have good reason to expect that two of the great African problems will be solved, the extent of the great lake, and the height of the equatorial mountains. There is reason to hope that light may also be thrown on the older problem of the sources of the Nile.

From a recent number of Petermann's Journal (1858, p. 344) we have translated the following passages which occur in a paper by Dr. Roscher, showing the reasons for his selection of the coast of Zanzibar as a point of departure for Central Africa.

In projecting the plan of an exploring expedition into Central Africa we must depend mainly upon the history of travels in those parts: for these will both suggest what is still to be accomplished and instruct us as to the means to be employed and the course to be pursued. A due regard to the experience

of earlier travelers will alone enable us to discover new routes into unexplored regions, upon which we need not expect to meet with those insurmountable barriers that have presented themselves to our predecessors; and yet the ready abandoning of expectations, prematurely indulged in respecting earlier and more recent expeditions, is a source of greater surprise than the fact that so large a portion of Africa remains unexplored.

All the accounts of travels, which have aided us in the construction of the map of Africa, do not give us any information relative to the central and northern portions of the interior of Africa, although these regions contain the solution of the most important geographical questions, and furnish the key to a proper conception of the physical features of the continent. The remarkable travels of Livingstone prove that an expedition into South Africa is attended with difficulties comparatively small, and that the failure to advance farther into the interior must be attributed, not to the hostility of the natives and the unhealthy climate, but mainly to the selection of an unfavorable starting-point. The course which has thus far been most frequently pursued, that of approaching the interior from the north, is the least practicable. The traveller meets with obstacles at the very boundary which separates the Mohammedan and heathen tribes; for among the former, fanaticism and avarice, among the latter, the fears of slavery, prevail, and every one advancing from the camp of the enemy is regarded as a spy. These insurmountable barriers have existed since the occupation of Africa by the Mohammedans, and here it was that the Arabian geographers, in their additions to the geography of Ptolemy, imagined the snow-covered Mountains of the Moon to be situated.

The Nile-expedition was thus prevented from penetrating any farther than the breadth of the river afforded them a protection against the assaults of the natives, which rendered it impossible for them to reach the source of the Nile. Dr. Barth also was convinced that an advance into South Africa from Lake Tsad was impossible, and hence, contrary to all instructions, he directed his course westward so that the original object of the expedition was not attained. Dr. Vogel was next sent out, and strong hopes were entertained that he might meet d'Escayrac at the source of the Nile, although even at that time it might have been proved that this point was the last one at which the two expeditions would be at all likely to meet. Dr. Vogel's journey to Waday furnishes the strongest proof that he, like his predecessors, was convinced that the so-called Mountains of the Moon, even if in reality no mountains, yet constituted an insurmountable barrier.

The time has certainly come when merely fruitless attempts must be done away with, and when travellers into Southern

Africa ought to take their point of departure in South Africa. There is no means of direct communication between any point on the western coast and Europe or with the Interior, and hence none is suitable for the fitting out of an expedition. The true condition of affairs in this region, may be best inferred from the opinion of Galton, who assumed that a traveller could advance into Africa only very gradually. Finding the arrangements previously made not suitable to the climate of the regions to be traversed, the traveller would be forced to return for the purpose of entering upon new preparations.

The expedition of Caillié, Bruce and Livingstone, prove how erroneous this assumption, and yet it is applicable to such travellers as seek to advance from the western coast, and by reason of the imperfect means of communication, daily meet with difficulties of which they could not have had any previous knowledge. Besides, the seaboard towns are, as a general thing, very unhealthy, and the fever is specially severe upon those newly arrived; so that the explorer on returning need not expect to experience a relief from his toils, but only new dangers.

The successful expedition of Dr. Livingstone has turned the attention of all to South Africa. The point of departure in his expedition, was Lake Ngami, a point equidistant from the eastern and western coasts. He congratulated himself upon the peculiar advantage of his seeming to be a traveller toward the country of the whites—homeward; for the savages can comprehend the utility of such a journey, and unless this is clear to them, they become suspicious and anxious to drive the stranger from their borders. In view of so important an advantage, this route cannot be too highly recommended to such as are in a situation similar to that of Dr. Livingstone, or do not dread the expense of a preparatory journey from the Cape to Lake Ngami; that is, to such as are willing to spend some time in that unhealthy region, in order to become acquainted with the country and its inhabitants, and then return once more to the cape to prosecute the final preparation for a more extensive expedition. North of Livingstone's route one can not expect to meet with a beaten path or with other travellers, hence the preparations must be more extensive, many requisites for the journey must be carried by the party, circumstances which will considerably increase the expenses. To other travellers this route will prove less desirable, from the fact that on the eastern coast there is a point which presents all the facilities requisite for the fitting out of an expedition; at this point too, the means of communication with Europe and the interior are adequate, nor will the traveller here meet with that great obstacle, the hostilities between the Mohammedan and natives. Nor here will he expose himself to a loss of life and health. Such are the advantages that the island of Zanzibar presents.

From this general survey of the difficulties of travel in Central Africa, Dr. Roscher proceeds to consider in an interesting manner, the characteristics of Zanzibar, but our limits do not permit us to follow this portion of his remarks.

North and Central Australia. Gregory's Expedition. Leichhardt's Fate.—In the last number of this Journal some account was given of recent explorations in South Australia, especially in the neighborhood of Lake Torrens.

We have since received from Rev. W. B. Clarke of Australia, a communication addressed by him to the Sydney Morning Herald of Sept. 10, 1858, in respect to the probable fate of Leichhardt, which gives us an occasion to refer to the explorations in the northern and central parts of the continent.

It is well known that the question has been much discussed in respect to Australia as well as in respect to Africa, whether or not in the interior of the continent, a great sea exists. Eyre, whose explorations were made in 1840 et seq., adhered to the belief that no such sea existed. On the other hand, Sturt, journeying north from Adelaide, 1844–6, although failing to discover an actual sea believed in its existence. The following remarks are given in his own words.

"The principal features of the interior are the sandy ridges or dunes, by which it is traversed from south to north, and the Great Stony Desert. That the whole region traversed was once submerged, there cannot, I think, be a doubt. Its salsolaceous productions, its sea-level, its want of trees of any size or growth, excepting on the banks of the creeks, sufficiently attest this; but whether the sandy ridges were thrown up simultaneously, or were successively formed by a joint effect of winds and a gradually retiring sea, or of winds alone, it is impossible to say. When I first crossed the Stony Desert, it appeared to me to have been the bed of a former current; and I felt satisfied that the conclusion was just when I crossed it at another point more than a degree from the first, and noticed the strong proof it exhibited of waters having at one time or other swept over it with unresistible fury. Whether the Stony Desert continues to any distance I cannot say, but my opinion is that it does, and that, as the lowest part of the interior, *it receives all the waters falling inwards from the coast.* Whether those waters are gradually lost by evaporation, or that they are carried to some still undiscovered sea, remains to be proved; but as it is difficult for others to elucidate these things, I have thought myself called upon to throw every light I can on the probable character of the interior. All I can say is, that after having traversed a desert for 400 miles and failed to reach its northern limit, and after having found that it continued unaltered for four degrees of longitude,

I cannot hope that it speedily closes in, either to the east or west."

In 1848, Leichhardt, whose previous journeys had made important additions to our knowledge of the northeastern parts of Australia, set out with a party of eight men to cross the continent from east to west, expecting to be gone two years and to determine the great question in respect to the interior. No news has been received from him since a short time after his departure. Hopes were entertained that Gregory's expedition would bring some news of his course and fate, but these expectations are disappointed.

An outline of Gregory's tour is thus given by Sir R. I. Murchison, on awarding to him the Founder's gold medal of the Royal Geographical Society of London.

"Having ascended the Victoria as far as was practicable, Mr. Gregory established a camp on the right bank of this stream, and at about 80 miles from its mouth. With his brother, Mr. H. Gregory, Mr. Wilson the geologist, and Dr. Ferdinand Mueller the botanist, he then explored the Victoria to Jasper Creek, determining the geological nature of the country, and ascertaining that the river made a great southward bend. Again taking with him his brother, and Dr. Ferdinand Mueller, together with the artist, Mr. Baines, he marched southwards to ascertain if the saline desert, which Sturt had discovered in proceeding inland from the southern regions of Australia, and which he had himself found to prevail in Western Australia, was also to be met with in a journey southwards from the north coast.

"For this purpose he ascended the Victoria to its source, and found the hilly or dividing range to have an altitude of 1660 feet above the sea. Traversing this watershed, he descended by a south-flowing stream, which he named Sturt Creek, and which, bending to the S.S.W., terminates in a desiccated salt lake near Mount Wilson, in S. lat. 20° 2′ and E. long. 127° 5′. Whilst the southeastern and southern slopes of the dividing range were thus proved to be everywhere dry and sterile sands, the whole of the territory to the north of the same presented the most striking contrast, being generally very fertile in grasses, particularly the extensive grounds named Hutt Plains and Roe Downs.

"In this first effort, therefore, made specially by the advice of our medallist Sturt, the grand geographical and statistical feature which was suspected to exist was brought to the test; and we may now fairly infer, that all the central portion of this continent, as well as the long southern coast-line examined by Eyre, and a considerable maritime frontier of Western Australia, constitute an uninhabitable desert, probably the dried-up bottom of a sea, and that hence all future intercourse between our Australian colonies must take place either along the fertile coast ranges, or by sea.

"Returning to his camp, which he had left under the charge of Mr. Wilson, the geologist of the expedition, who had in the mean time examined the adjacent country, of which he sent home sketch maps to this Society, Mr. Gregory sent away Mr. Baines the artist, with Mr. Wilson, and the larger number of his party, in the schooner; and after giving directions that the vessel should meet him at the head of the Gulf of Carpentaria, he set out on his chief mission, accompanied by his brother, Mr. Elsey the surgeon, Dr. Mueller the botanist, and three men.

"Quitting the basin of the Victoria, and passing over a broad table-land of sandstone, he entered a valley watered by a tributary of Leichhardt's river the Roper, which he named Elsey Creek, in S. lat. 15° 15′ and E. long. 133° 10′. He next took a south-southeasterly direction to the west of Leichhardt's route, or about 70 miles distant from the western shore of the Gulf of Carpentaria, and traversed the various rivers discovered by his adventurous precursor (but nearer to their sources) until he reached the Albert, which empties itself into the head of the Gulf. Not meeting there with the party sent by sea, under the orders of Mr. Baines, he left the 'Plains of Promise' of Stokes, and crossed the river Flinders at about 80 miles distance from the Albert, and, journeying to the northeast, fixed a position on the Gilbert river at S. lat. 18° 0′ and E. long. 140° 40′. Ascending that stream, Mr. Gregory left behind the drainage into the Gulf of Carpentaria, and traversed the high basaltic plateau which separates the waters flowing into that gulf from those which descend into the great eastern ocean. To the dividing high lands he assigned the name of 'Newcastle Range,' in honor of the Secretary of State for the Colonies, who had sanctioned and organized the expedition. Reaching the Burdekin, he followed that stream southeastwards to its junction with the Cape river of Leichhardt.

"The next march showed the connection of the Suttor of Leichhardt with the Belyando of Mitchell; then striking southwest from the latter stream, Mr. Gregory skirted the Peak range, the extreme point to which squatters have extended their dwellings, *i. e.* in S. lat. 23° 41′ and E. long. 147° 50′, or about 560 miles from the head of the Gulf of Carpentaria.

"Whilst a great breadth of entirely sterile tracts, with one insulated rich spot only on the river Roper, prevail between the basin of the Victoria on the north coast and the Gulf of Carpentaria, with occasional poisonous plants, Mr. Gregory found nearly all the vast region between the eastern side of the gulf and the northernmost station of our settlers to be more or less fertile. So that in the last weeks of the expedition the horses fattened, and after traversing the rivers Mackenzie, Comet, Dawson, and Burnett, the party reached the Brisbane and Moreton Bay in excellent health."

The publication of Mr. Gregory's report, without any decisive indications of Leichhardt's route, led Mr. Clarke to prepare the paper already referred to in the hope that the discussion might initiate another expedition into the district yet unexplored, between the 145th and 147th meridians, and which, as he conceives, may bear traces of Leichhardt's route, although the explorer probably perished far to the northward and westward of the Victoria. We have not room to make extended extracts from this paper. Its whole tendency is to show that the intention of Leichhardt was to skirt and not cross the desert. There is an extended criticism to show the probability that an L found by Gregory on the Victoria, and two marks XVA in an L-shaped border previously found near the Warrego and the Nive were not the marks of Leichhardt. Various independent witnesses are also cited to confirm the opinion of Mr. Clarke that Leichhardt did not attempt to intersect the desert. The article concludes as follows.

"If then he did reach the Victoria in 1848, and was not cut off, and we have now no ground to conclude he was, he would, in case of finding the country impracticable to the west, have gone round by the head of the Victoria, towards the north, and it is somewhere between the head of the Victoria and the head of the Clark, that, I think, his tracks are to be looked for; not, probably, on any line of route explored by Mitchell, but to the westward, or, crossing Mitchell's track, on a line to Peak Range and the Burdekin. Or driven in by drought, he may have taken a course on the 148th meridian, without going across the Maranoa, where Hely could not trace him, on a new track of his own.

"It is in the hope that a new expedition may be organized, with a view to the exploration of the country west of Mitchell's Belyando, as well as to ascertain whether any traces of my lamented friend can be found, that I have made this communication; believing that, as I have had it in my power to put the matter in a tangible form, and to quote from manuscript notes in my possession, what has not before been committed to the press, I am only rendering a service to the cause of science, civilization, and humanity."

The following paragraph may be read with interest in this connection. It is a letter of Dr. J. Palacky of Prague to Prof. C. Ritter of Berlin, printed in Poggendorf's Annalen für Chemie, vol. 100, 1857.

"The statement of Sturt that Lake Torrens must lie below the level of the sea, led me to think that Central Australia must lie very deep. I found unfortunately no other data than in Sturt, Bd. ii, p. 299, where in connection with Kennedy's route to the Victoria river—it is mentioned that in lat. 25° 55′ 37″ and long.

142° 24′, the water in the camp when the air was at a temperature of 64° Fahr., had boiled at 214° F. Prof. Coritska, who directs the height measurements of our Geological Reichsanstalt, undertook at my request the computation of these data and found that if they are correct, this point must lie 306 meters below the sea level."

ART. XXIX.—*Analysis of the White Sulphur Water of the Artesian Well of Lafayette, Indiana;* by CHARLES M. WETHERILL, Ph.D., M.D.

History of the Well.—The artesian well of Lafayette is situated in the northeast angle of the court-house square of the city. The boring was commenced in the spring of 1857 by order of the Commissioners of Tippecanoe county to test the feasibility of artesian wells for prairie farms, and with prospects of success from the results of the wells in Illinois to the southwest. On February 18th, 1858, after ten months labor, a vein of overflowing water was struck in the grey limestone, at a depth of 216 feet 6 inches. The depth of the well was subsequently increased to 230 feet without any change in the character of the water, which is very similar to that of the celebrated Blue Licks, of Kentucky. The strength of flow of the water began to diminish, and while injudiciously boring for more water instead of trying to stop a known leak, the water suddenly ceased to overflow, and fell in the well about 20 feet. As there was no prospect of the recovery of the water by the contractor, the County Commissioners placed the well in the hands of Captain Rogers and myself, for the purpose of obtaining some experimental knowledge with respect to the source of the difficulty. Before giving the results of our experiments, I will submit a table which shows the order and nature of the strata encountered in boring the well:

Table of Strata encountered in the Lafayette Well.

	Feet.	Inches.	Remarks.
Clay	3		
Clay and gravel	9	6	Water.
Gravel and pebbles	1	6	
Fine gravel and sand	13		
Quicksand	1		
Gravel, clay and pebbles	2	6	
Dark gray clay	72		Marlite.
Sand and gravel	4		Water.
Clay and pebbles	1	3	
Sand and gravel	7	3	
Clay		6	

	Feet.	Inches.	Remarks.
Sand and gravel	3		
Clay and pebbles	6	6	
Gravel and pebbles	5		
Boulders	40		
Blue shale	2		To shale 170 feet.
Gray "	18		Iron pyrites in all the rock formation.
Blue "	1	6	
Gray "	7		Thickness of shale 28 ft. 6 in.
Limestone—coralline	11	6	To coralline, 198 ft. 6 in.
Gray limestone with spar	20		Overflowing water.
Depth of well from original surface	230		

The first water in the table is the well water of the locality. The water under the marlite is fresh; it was expected to overflow but only rose to within 36 to 38 feet of the surface. The third and overflowing water is the mineral water.

A cast iron pipe of eight inches diameter cases the well to the first rock, which is a friable blue shale. The hole in the rock was not tubed, it was of 7½ inches in diameter to near the commencement of the coralline; for a few feet farther it was of five inches, and for the remaining distance of twenty-one feet its diameter was four inches. We found that the bottom of the iron pipe had been broken during its passage through the forty foot bed of boulders, and as this fractured end rested upon a friable bed of blue shale with porous strata immediately above, a leak of the mineral water had always existed. From an experiment made during the overflow of the water we were able to assign a delivery of eighteen thousand gallons during twenty-four hours as the lowest capacity of this leak. We found that the cessation of overflow was caused by the leak having been increased by the removal of a piece of the shale rock. Restoring the overflow by stopping this leak was the natural inference from the experiments upon the well; but there were difficulties in the way owing to the bad shape of the hole in the rock, by the use of improper boring tools. The holes were all of triangular shape, and the four inch hole was especially bad, having reëntering sides and semicircles at the three angles. We might have arrested the leak by tamping and puddling at the end of a long tube below it, but were fearful of presenting difficulties thereby in the case of the removal of such a tube, for as the leak at the top of the shale rock had always existed, we had no means of knowing whether some of the mineral water was not derived from the shale, and would be shut out by such a tube.

The leak was at length arrested by the following device of my own, which I submit in the event of a future need for it, as it proved simple and successful in the Lafayette well, and I am not aware that it has ever been employed in a similar case. The

commencement of the four inch hole was made truly cylindrical and of six inches in diameter for a distance of nineteen inches. A car spring of vulcanized india rubber was turned in a lathe to the shape of the frustum of a cone six inches in length, and of diameters six and a quarter and five and seven-eighths inches. Upon a wrought iron gas pipe of two and a half inches bore and of sufficient length to reach the coralline rock, was chised a screw thread upon which ran two heavy nutts. The hole in the rubber plug was turned sufficiently large, that the plug might be screwed tightly upon the gas pipe, where it was secured for pulling or pushing by the nutts above and below it. When the pipe was placed *in situ* in the well, the plug was arrested in its rocky socket just above the commencement of the coralline rock. The water at once fell outside of the gas pipe, and rose on the inside to near the surface of the ground. After two days it commenced to overflow and increased constantly and steadily. The increase at first was very rapid, the delivery doubling itself in five hours; a repeated and careful measurement of the quantity of water showed that the *rate of increase* fluctuated, and became gradually less. This compelled the inference that the leak had lowered the head of water in the reservoir supplying the artesian well, which head was gradually restored by the rains, springs, &c., upon shutting off the leak. This increase in the flow will go on until the overflow equals the feed of the reservoir. When the delivery was last measured on December 8th, it equalled one wine gallon in 14·77 seconds, or 5850 gallons in twenty-four hours.

Geology of the well.—The order and character of the rocks in proceeding from a point west to one east of Lafayette, is from information furnished by D. Brown, State Geologist, as follows:

1. Seams of Coal.
2. Mountain Limestone about 200 feet in thickness.
3. Clay Sandstone (Devonian) about 500 feet.
4. Delphi Slate varying from 25 to 100 feet, and thinning to the northwest.
5. Grey Limestone (Upper Silurian).
6. Blue Limestone (Lower Silurian).

The dip of these rocks is about 25° to the south of west, and at an angle of 50 feet fall to the mile. This westward dip is maintained until the Mississippi is crossed, when the dip is eastward. The sequence of the rocks, in penetrating the earth vertically at Lafayette, should be Clay Sandstone, Delphi Slate, and Grey Limestone; but the valley of the Wabash at the artesian well is about one hundred feet below the general elevation of the country, and the force which has scooped out this valley has removed the Clay Sandstone, not a trace of which was discovered in boring the well. The Delphi Slate was the first rock reached

after traversing the drift, and the bottom of the well is situated in the upper measures of the grey limestone. A crude idea of the strike of these rocks may be gained by tracing upon a map of Indiana the strike of the Delphi slate, by a curved line joining Louisville, Ky., Lexington, Ind., Elizabethtown, Indianapolis, Delphi and Crown Point, Ind., which shows that the well is situated upon the edge of a great geological basin. As far as our present geological knowledge goes, (and which is limited owing to a backwardness on the part of the State Legislature in making the appropriations necessary to a survey,) the reservoir of the artesian well must lie in the direction of and beyond Delphi, for the water comes from below the slate cropping out at this locality. A glance at the map will show by the river courses, that Kokoino is the highest ground in the neighborhood; hence we shall probably not be far from the truth in assuming the reservoirs to be situated somewhere in the triangle formed by joining Delphi, Logansport and Kokoino. During the experiments upon the well by Captain Rogers and myself, one of the greatest freshets in the Wabash, within the memory of the inhabitants of the valley took place. The leak had not yet been stopped, and we found that the water in the well rose and fell simultaneously with the freshet. It is reasonable to suppose that this effect of the freshet was not upon the mineral waters but upon the water under the marlite (see table of strata); for the smaller freshets in the river since the leak has been stopped have not in the least affected the flow of the well. This can only be accounted for by supposing that the 72 foot bed of dark grey clay crops out under the Wabash at a level lower than that of the ground at the well. It follows from this that we cannot expect an overflow of this marlite-water in the neighborhood of Lafayette. In fact since the completion of the mineral well, three other wells have been dug in the city for the expressed purpose of reaching the marlite-waters. It was obtained in every instance, but did not overflow.

CHEMICAL ANALYSIS OF THE WATER.

Physical Characters.—This water is of extreme limpidity when taken freshly from the well. The deposit upon the pebbles over which it flows is *white*, entitling it to the name of a *white sulphur* water. Standing in imperfectly closed vessels, a similar bluish white deposit takes place, which under certain conditions contains black flakes of sulphuret of iron. The smell of the water is strongly of sulphuretted hydrogen. The taste is similar to that of the celebrated Blue Lick water, though less strong. It is pleasantly brackish, resembling in taste, the liquor from oysters freshly opened. The density, from a mean of six observations is 1·00523.

The temperature, noted at intervals since the water was first obtained, (Feb. 18th to December 8th,) remained constantly between 55° and 56° F., my thermometer not being sufficiently delicate to give more definite results.

Although the mean temperature of Lafayette is unknown,* I have no doubt from other considerations, that the artesian water is "thermal;" for, first, the calculated temperature of the water upon the Grenelle basis renders this, in absence of contradictory facts, most probable. It will be remembered that thermometers placed in the wells of the Paris observatory stand invariably at 53° F., at a depth of ninety feet, and that from the increase of temperature at increased depths observed in boring the Grenelle well, the fact was established that the temperature rises one degree F., for every $61\frac{4}{10}$ feet, after the first ninety feet. After taking ninety feet from the depth of the Lafayette well there remain 140, and if the same ratio of increase of temperature exists as at Grenelle, the water should have a temperature of $2\frac{1}{4}$° above 53°=$55\frac{1}{4}$°, which agrees closely with the temperature actually found for the Lafayette water. Secondly, we infer that the artesian water is "thermal" from the fact that its temperature is above that of the neighboring springs and wells, as may be seen from the following table, which contains wells and springs situated at different points of the compass from the artesian well, and within a circle of two squares radius.

Temperature of the Wells and Springs of Lafayette, taken April 30, 1858.

	Locality.	Depth Feet.	Direction from Artesian well.	Temperature. Air.	Water.
Well,	Mr. C. Taylor's dwelling,	25	South	78° F.	51° F.
Well,	Courthouse yard,	16	Southeast	"	51°
Well,	Wilstach's Drug Store,	16	North	"	48°
Spring,	Two squares from Artes. Well,		North	81°	50°
Well,	Mr. Benbridges' dwelling,	20	Southeast	80°	49°
Spring,	Messrs. Taylor & Co., lumber yard,		Northwest	"	50°
Well,	Cellar of Mr. J. Mix's store,	16	West	56°	49°
Well,	Lahr's Hotel,	16	East	80°	50°
Artesian w'll,				80°	55–56°

Chemical Characters. Qualitative.—The water is faintly acid from sulphuretted hydrogen and carbonic acid, but becomes neutral after having been boiled, owing to the expulsion of these gases. It follows from this fact that *all* of the sulphur is in the state of sulphuretted hydrogen dissolved in the water, and from the neutrality after boiling, that alkaline carbonates are absent. A particular experiment for the search of a trace of alkaline carbonates gave the same results.

Carbonic acid is contained dissolved in the water, and holding in solution the earthy carbonates. Nitrogen is the only remain-

* The mean temperature is probably 51° to 52° F.—Eds.

ing gas in solution. On boiling the water the carbonates of lime, magnesia and iron, held in solution by the carbonic acid, are thrown down, and by a slight concentration, sulphate of lime is also precipitated. In the boiled water chlorids of sodium, calcium and magnesium, were detected. Crenic and apocrenic acids were in vain sought. A trace of organic matter was found dissolved in the water. The only alkali present is soda in the state of chlorid of sodium. No trace of potassa was discovered after a careful search. Mr. H. C. Lawrence kindly undertook the concentration of eleven and a half wine gallons of the artesian water, which were boiled down to half a gallon; a concentration in the ratio of 23 to 1. In the solid residue and filtrate, I detected phosphate of lime, hydrofluoric acid, alumina and a very faint trace of oxyd of manganese. A small trace of iodine was discovered in the mother liquid, both by the starch test and by chlorid of palladium. With the starch test the characteristic blue tinge could not be developed by chlorine water, the excess of chlorine decolorizing the extremely minute quantity of iodid of starch; but it was readily brought out by nitric acid. The result of the bromine test by Fresenius's method was doubtful.

Quantitative analysis.—The quantitative analysis gave the following results:

	Per mill.
Mean of two exp., sulph. acid determination,	0·5621
" " chlorine,	3·7807
Sodium by calculation, (loss,)	2·1782
" " experiment,	2·1683
Peroxyd of iron, mean of two exp.,	0·0085
Silica,	0·0080
Lime—total,	0·5386
" after boiling the water, in the precipitate,	0·1149
" " " " " in the solution,	0·4255
Magnesia—total,	0·2005
" after boiling the water, in the precipitation,	0·0039
" " " " " in solution,	0·2088

Sulphur, carbonic acid, and nitrogen as stated below. These data calculated according to the ordinary rules give the following result:

Composition of the White Sulphur water of the Lafayette Artesian well. Water of March 25th, 1858.—Temperature 55°–56° F. Density, 1·00523.

GASEOUS CONTENTS.

	In 1000 grams. Grams.	Cub. centim.	In a wine pint. Cubic inches.
Sulphuretted hydrogen,	0·0093	6·3594	0·1841
Ditto water of April 8,	0·0145	9·9154	0·2870
Carbonic acid,	0·0997	52·683	1·5253
Nitrogen,		21·280	0·6160

SOLID INGREDIENTS.

	In 1000 parts by weight.	Grains in a wine pint.
Residue by evaporation, Pure water, ...	992·75	7274·446
Solid ingredients,.......	7·25	53·124
	1000·00	7327·570*

INGREDIENTS BY ANALYSIS.

Carbonate of lime, ...	0·2052	1·503
Carbonate of magnesia,.....................	0·0069	0·050
Peroxyd of iron with alumina, ... Phosphate of lime, fluorid of calcium,.......... And a faint trace of manganese, ...	0·0085†	0·062
Silica, ...	0·0080	0·058
Sulphate of lime, ...	0·9555	7·002
Chlorid of calcium,........................	0·0635	0·465
Chlorid of magnesium,......................	0·5059	3·707
Chlorid of sodium, ...	5·5402	40·596
Trace of iodine and organic matter,........... Bromine doubtful,..........................		
	7·2937	53·443

I have recalculated the analyses of the principal sulphur waters of the United States to the same measure, a wine pint, and tabulated them as follows, for the sake of a ready comparison: (see table on following page).

By reference to the table, the great analogy is at once apparent which exists between the Lafayette water and that of the Kentucky Blue Lick. They contain, with a few trifling exceptions, the same ingredients. The exceptions are the sulphate of potassa and chlorid of potassium, contained in the Blue Lick alone, and the chlorid of calcium, contained above in the Lafayette water. The latter water contains less sulphuretted hydrogen, and carbonic acid, and less solid matter. It is curious that the common salt bears almost exactly the same ratio to the rest of the salts in both waters.

Total Salts.			Common Salt.	
Blue Lick.	Lafayette.		Blue Lick.	Lafayette.
79 :	53	: :	64	: x=42

The common salt (x,) in the Lafayette waters, is by experiment nearly 41.

In round numbers one and a half pints of the Lafayette water contain as much common salt as one pint of the Blue Lick water. The magnesia salts bear a greater proportion to the rest of the salts in the Lafayette water than in the Blue Lick.

* This is the weight of a wine pint of the artesian water; the weight of the same measure of pure water being 7291·11 grains.

† Equivalent to carbonate of the protoxyd of iron 0·0061 per mille.

Tabular view of the principal Sulphur Waters of the United States. Expressed in grains in the wine pint.

	Name of Springs.	Temperat. F.	Density.	Carbonates. Lime.	Carbonates. Magn.	Carbonates. Bic'b. Mag.	Sulphates. Lime.	Sulphates. Mag.	Sulphates. Potas.	Sulphates. Soda.	Chlorids. Calc.	Chlorids. Mag.	Chlorids. Pot'm	Chlorids. Sodium	Iodid. Magnesium.	Bromid Magnesium.	Name of analyst.
Sharon, N. Y.	Sulphur Spring,						6·98	2·65				0·15		0·14			Chilton.
	Magnesia Spring,					3·81	9·50	2·83				0·36*					L. Reed.
Avon, N. Y.	New Spring,	50°	1·00356	3·37			0·44	1·01		4·84				0·71			Hadley.
	Middle Spring,	51°		1·00			10·50	1·25		2·00				2·30			Hadley.
	Lower Spring,	45°–47°	1·0018	3·58	....		7·17	6·21		1·71	1·05						Chilton.
	Sylvan Spring,			3·35	2·0		10·05	1·62				7·8		12·18	trace.		Chilton.
Virginia,	Greenbrier White Sulphur,			1·15			7·744	5·588			0·204			0·180			Rogers.
Kentucky,	Blue Lick,	62°	1·007	2·957	0·017		4·25		1·117			4·049	0·174	64·107	0·005	0·030	Peters.
Indiana,	Artesian Well, Lafayette,	55°–56°	1·00523	1·503	0·050		7·002				0·465	3·707		40·596	trace.	?	Wetherill.

	Name of Springs.	Metallic Sulphurets.	Oxyd iron, etc., etc.	Silica.	Organic matter.	Loss.	Total grains in a wine pint.	Cubic inches of gas in a wine pint. Sulphuretted Hydrogen.	Carbonic acid.	Nitrogen.	Oxygen.	Name of analyst.
Sharon, N. Y.	Sulphur Spring,	0·14†					10·06	1·00				Chilton.
	Magnesia Spring,	0·06‡					16·57	0·41				L. Reed.
Avon, N. Y.	New Spring,						10·37	3·91				Hadley.
	Middle Spring,						17·05	12·00	5·60			Hadley.
	Lower Spring,						19·72	1·32	0·50			Chilton.
	Sylvan Spring,				0·03		37·03	2·58	0·32	0·67		Chilton.
Virginia,	Greenbrier White Sulphur,		trace.		trace.	0·41	15·276	0·175 to 0·343§	0·25	0·444	0·181	Rogers.
Kentucky,	Blue Lick,		0·045	0·137	trace.	2·216	79·104	0·334	5·337			Peters.
Indiana,	Artesian Well, Lafayette,		0·062	0·058	trace.		53·443	0·184 to 0·287	1·525	0·616		Wetherill.

* Chlorids of Magnesium and Sodium.
† Sulphurets Calcium and Sodium.
‡ Sulphurets Calcium and Magnesium.
§ 0·032 by Dr. Hayes' analysis.

The sulphuretted hydrogen of the Lafayette water is equal in quantity to that ingredient in the Greenbrier White Sulphur water of Virginia, and varies as in that water. I established this fact by many and careful sulphur determinations of the Lafayette water by the chlorid of arsenic test upon water taken at the spring. I have also made frequent careful density determinations of the water during a period of six months, and have found the specific gravity invariably to the third decimal point, proving an invariable mineral composition for the water during that time.

The Lafayette water has been used with great success in the diseases for which sulphur waters are applicable.

I have noticed in the neighborhood of this city several chalybeate springs. A very fine one is situated upon the shore of Barnett's creek, which flows through the celebrated battle-ground of Tippecanoe at a distance of seven miles from Lafayette. The temperature of the water was 53° when that of the air was 84°. It strikes a dark color with extract of galls, has a strong chalybeate taste, and coats the stones over which it flows with an ochreous deposit.

ART. XXX.—*On the Measurement of the Striæ of Diatoms;* by W. S. SULLIVANT and T. G. WORMLEY.

NO characters are so constant for distinguishing the species of diatoms as those drawn from the striæ on their frustules. The accurate measurement of these striæ has not received the attention, particularly among European microscopists on the continent, that might have been expected from the general interest taken in the study of these beautiful organisms.

Attention appears to have been first directed to this subject in Silliman's Journal for 1849–50, by the late distinguished Professor J. W. Bailey of West Point, and Mr. De La Rue of London, in their papers on the marking of Pleurosigma Spencerii, the measurements of which, made by the latter gentleman, remaining to this day a reliable standard for comparison. In 1853 the first volume of Smith's admirable synopsis of British Diatomaceæ appeared, in which the striation of numerous species, is, for the most part, correctly determined. Next in order of time is the paper of Messrs. Harrison and Sollitt, read (1854) before the British Association for the Advancement of Science, giving measurements (widely different from those in Smith's Synopsis) of several well known species.

The above, including the second volume of Smith's Synopsis, embraces about all the information on record, relating to the subject of these papers, known to the writers.

The measurements of the larger portion of the following species were made on authenticated English specimens. The figures affixed to each species express the number of transverse striæ in the $\frac{1}{1000}$th of an inch (·001″), as determined by us; next following and in parentheses are the measurements, if any, of other observers. In not a few cases it will be seen that our measurements accord very nearly with those in the Synopsis, not differing more than might be expected in observations of this kind: besides it is well known that the striation of each species varies within certain limits peculiar to the species. In other cases, however, there are discrepancies between our measurements and those in the Synopsis, too great to be accounted for in this manner.

Nitzschia sigmoidea, 72 to 75; (85, Smith); (105, Harrison and Sollitt).—N. obtusa, 54; (56, S.).—N. plana, 50; (56, S.).—N. linearis, 73.—Stauroneis linearis, 65.—Cocconeis Thwaitesii, 54; (72, S.).—Amphora membranacea, hoop 53, valve 36; (80, S.).—Cymbella cuspidata, 35; (30, S.).—C. Scotica, 45; (42, S.).—Navicula lanceolata, 40; (44, S.).—N. firma, 42; (42, S.).—N. ambigua, 38; (36, S.).—N. sphærophora, 40; (42, S.).—N. lævissima, 51; (48, S.).—N. rhomboides, 70; (85, S.).—Pinnularia Johnsoni, 48; (56, S.).—Fragillaria virescens, 40; (44, S.).—F. Capucina, 40; (40, S.).—Colletonema vulgare, 72; (72, S.).—C. eximium, 56; (56, S.).—Achnanthidium coarctatum, 34; (40, S.).—A. lanceolatum, 33; (40, S.).—Amphipleura inflexa, 52; (52, S.).—A. pellucida: we have not been able even to "glimpse" the striæ on this diatom. Messrs. Harrison and Sollitt in their paper above cited, estimate the striæ at 125 to 130 in ·001″.—Himantidium pectinale, valve 27, hoop 48; (v. 27, h. 48, S.).—Pleurosigma macrum, 70; (85, S.).—P. angulatum, 45 to 50; (52, S.); (75, H. & S.).—P. Spencerii, 48 to 50 tr., 55 long.; (52 tr., 55 long., S.); (120 to 200, Bailey).—P. attenuatum, 36 tr., 32 long.; (40 tr., 30 long., S.).—P. fasciola, 56; (64, S.); (90, H. & S.).—P. littorale, 40 tr., 22 long.; (50 tr., 24 long., S.).—P. acuminatum, 45 tr., 40 long.; (52 tr., 40 long., S.).—P. strigosum, 42; (44, S.).—P. Hippocampus, 38 tr., 32 long.; (40 tr., 32 long., S.).—P. lacustre, 42; (48, S.).—P. quadratum, 45; (45, S.); (70, H. & S.).—P. speciosum, 42; (44, S.).—P. prolongatum, 55; (65, S.).—P. strigile, 30 tr., 35 long.; (36 tr., 40 long., S.).—P. elongatum, 48 to 50; (48, S.); (60, H. & S.).—P. distortum, 60; (75, S.).—P. formosum, 36 tr., one set of oblique striæ 24, the other 30; (36, S.).—P. decorum, 45 tr., 36 oblique; (36, S.).—P. intermedium, 56; (55, S.).—P. Balticum, 36; (38, S.).

—P. Wormleyi, 52.*—P. obtusatum, 56.†—P. Sciotoensis, 40.‡—Synedra radians, var.? a common fresh water species in this vicinity, has on the hoop about 75 striæ in the ·001″, very difficult, when balsam mounted, to resolve, owing probably to their shallowness.—Grammatophora subtilissima, 70 to 75 on the Greenport variety, 75 to 82 on the Providence variety.—Hyalodiscus Californicus: a large valve ·005″ in diameter (the central disc or umbilicus measuring ·0016″) gave at the margin of the umbilicus about 65 straight radial lines in ·001″; midway between that point and the circumference of the valve near 70 in ·001″; and at the circumference about 75 in ·001″. More or less of these lines from the margin of the umbilicus, before reaching the circumference, bifurcate: this accounts for their being coarser near the umbilicus than at the circumference, as is shown by the above measurements, and by the greater ease with which they are resolved near the former point. The umbilicus itself is rayed, and in certain portions of the light exhibits curved lines.

To those interested in these matters it may not be unacceptable to state the means and method by which the above measurements were obtained. The objectives used were two $\frac{1}{12}$ths, one by Spencer, the other by Ross, and a $\frac{1}{16}$th by Powell and Lealand, upon one of Smith and Beck's first-class stands, with their second eye-piece and Jackson micrometer. An important adjunct to the above was Tolles' amplifier which consists essentially of an achromatic meniscus lens placed between the objective and the eye-piece, affording an amplification much superior to that from ordinary eye-piecing. The value of the Jackson micrometer (a scale of ·005″) with each of the objectives was carefully established by the averages of numerous trials on two of Smith and Beck's stage scales of ·001″. Thus the smallest divisions of the Jackson micrometer were made by moderate

* Pleurosigma Wormleyi, Sulliv.—Lanceolatum, conspicue sigmoideum, in apices acutos subito attenuatum; long. ·003″; striis trans. et long. 52 in ·001″.
Fresh water; Columbus, Ohio, *Prof. T. G. Wormley;* Genessee river, N. Y., *Mr. C. A. Spencer.*
Resembles P. Spencerii, but is a smaller species, more evidently sigmoid and with rather abruptly attenuated ends: its striæ are more difficult to resolve, being shallower: texture of the valves thinner.

† Pleurosigma obtusatum, sp. nov.—Oblongo-lanceolatum, leviter sigmoideum, apicibus obtusis; long. ·0025″; striis trans. et long. 56 in ·001″.
Fresh water; Columbus, Ohio: Gambier, O., *Prof. H. L. Smith;* Genessee river, *Mr. C. A. Spencer.*
A very small species remarkable for the obtuse ends. It may be a Colletonema, but we have not observed it in gelatinous envelopes.

‡ Pleurosigma Sciotoensis, sp. nov.—Lineare, modice sigmoideum, in apices obtusiusculos sensim attenuatum; long. ·005″; striis trans. et long. 40 in ·001″.
Fresh water; Columbus, Ohio: Genessee river, N. Y., *Mr. C. A. Spencer.*
Not unlike P. Spencerii, for which it has passed as a variety, but is a larger species, its valve having more parallel sides and less acute ends. Its striation at once distinguishes it. Dry valve pale straw-color.

draws of the draw-tube to measure with different objectives from ·000025″ to ·00000167″ under an amplification of 1700 to 3600 times; precautions being taken against any disturbance of said value, that might arise from the thin glass covering the object. A Powell and Lealand cobweb micrometer was occasionally used, but mostly for corroboration. The Jackson micrometer, upon the whole, was found to be more manageable and satisfactory, the shortness of its lines permitting their coincidence with the striæ to be more readily observed. The light employed was sunlight, admitted through a small aperture into a darkened room: with no other light could the striæ of the highest marked frustules be distinctly resolved under an amplification sufficient for counting. In order to diminish as much as possible the chances of error, the counting always embraced as many contiguous striæ as covered a space equal, at least, to that between the centres of the *five-lines* of the micrometer, and when practicable a larger number was counted.

In conclusion, we may remark that our experiments are confirmatory of the generally received opinion that striæ closer than about 85 in ·001″ have not yet been resolved. Whether this limit is interposed by the physical properties of light, or whether it arises from defects still existing in our apparently faultless instruments, remains to be determined.

Columbus, Ohio, January 18th, 1859.

Art. XXXI.—*Correspondence of Prof. Jerome Nicklès, dated Paris, January 3rd,* 1859.

On the nature of simple bodies.—The Comptes Rendus for December contains a long memoir by Despretz on his researches to ascertain whether certain of the so-called elements are decomposable. His laborious and careful investigations have led to no decomposition, and he announces the conclusion that the substances called elementary are really elementary or incapable of decomposition. The author should have added, that they were not decomposable by the methods he used, for it is not probable that there is nothing more to be done in this branch of research. His process consists in submitting the element—cadmium for example—to the physical and chemical reagents ordinarily employed in analysis. He transforms it into an oxyd, then into salts of all kinds, decomposes these salts by chemical and galvanic methods, precipitates the metal at one time at the positive pole, at another at the negative, examines the crystalline form, turns it again into salts, which he decomposes, vaporizes the metal by means of the pile; and thus causes an element to pass through a great number of different states, and still arrives at the same element. While rendering justice to the zeal and patience of Mr. Despretz, we have to regret that these good qualities have been here wasted,

for the researches would be a hindrance to the progress of science if taken seriously.

Dumas took upon himself the refutation of Mr. Despretz, and brought to the subject his well known ability. He prefaced his remarks by presenting the following table which exhibits an interesting relation between the equivalents of certain simple and compound bodies.

Fl 19	Cl 35·5	Br 80	I 127	Difference 5.
N 14	Ph 31	As 75	Sb 122	
Mg 12·25	Ca 20	Sr 43·75	Ba 68·5	Pb 103·5	Difference 4.
O 8	S 16	Se 39·75	Te 64·5	Os 99·5	
Ammonium 18	Methylamine 32	Ethylamine 46	Propylamine 60, etc.	Diff. 3.
Methylium 15	Ethylium 29	Propylium 43	Butylium 57, etc.	

As this relation suggests a doubt as to the elements being simple, Dumas took occasion to express his opinion on this important question.

Since the radicals (elements) in mineral chemistry present the same general relations as those in organic, he believes there is reason for bringing the two branches more closely together than is usually done. We can decompose the latter, and there is no proof that we may not decompose the former. The following are the conclusions in his memoir which will soon be published.

(1.) The compounds which the three kingdoms offer for our study, are reduced by analysis to a certain number of radicals which may be grouped in natural families. (2.) The characters of these families show incontestible analogies. (3.) But the radicals of mineral chemistry differ from the others in this, that if they are compound, they have a degree of stability so great that no known forces are capable of producing decomposition. (4.) The analogy authorizes the enquiry whether the former may not be compound as well as the latter. (5.) It is necessary to add that the analogy gives us no light as to the means of causing this decomposition, and if ever to be realized, it will be by methods or forces yet unsuspected.

Spontaneous generation.—Mr. Pouchet, Professor of Zoology at Rouen, is a decided believer in spontaneous generation, and has undertaken to revive this theory which has been overturned by the experiments of Schultze and Schwann, as well also by those of Messrs. Schroeder and Dusch. The former have shown that animal substances do not ferment when they are enclosed in air which has previously traversed a red hot tube. The latter state that these same substances may be preserved indefinitely in air which has previously been made to pass through a tube containing cotton. They have alike concluded from their experiments that fermentation and putrefaction are only the results of the life of certain inferior animalcules whose germs were in the atmosphere, and which are developed at the expense of the fermentible substance. Remove these germs either by filtration or calcination and there is no fermentation or putrefaction.

The mechanical theory of Liebig, which has at least as much probability in its favor as the physiological just mentioned, opens a way of explanation independent both of this and spontaneous generation.

The work of Mr. Pouchet was some time since announced, and the great success of the naturalist of Rouen proclaimed. It was stated that

he would surprise the scientific world with a prodigious number of experiments directly opposed to all received ideas.

The following are the results announced. He has seen cryptogams and animalcules to be produced in vessels when every organic germ has been previously destroyed and when the air had been washed in sulphuric acid or had traversed a tube of porcelain heated to a red heat. He has even succeeded in developing organic beings in artificial air and also in pure oxygen.

The details of one of his experiments are as follows. A flask, holding a litre, was filled with boiling water, then hermetically sealed with the greatest precaution, then inverted in a mercury trough; then when the water is cold, it was opened under the mercury and half a litre of pure oxygen introduced. Immediately after was added to it, under the mercury, a small box of hay weighing 10 grams, which had just been raised, in a flask, by means of a stove to a temperature of 100° C. and kept at this temperature for 30 minutes. The flask was then hermetically sealed by the aid of its stopper ground with emery; and to make it sure, when taken from the mercury a coat of varnish and vermilion was put over the aperture.

Eight days afterward, small globules were found in the liquid and on the hay. On opening the flask at the end of ten days, the oxygen appeared to have remained pure. The whitish globules were due to a fungus in tufts which Mr. Montagne, the micrographer, called *Aspergillus Pouchetii.*

A plant is thus developed in a medium from which it was endeavored to exclude every species of organic germ; but the conclusion of Mr. Pouchet is quite too general, as no facts prove that every kind of vitality was destroyed during the exposure of the hay for 30 minutes to 100° C.

Ozonometry in the Crimea.—During the Crimean war, the French army physicians, established three observatories for ozonometric, thermometric and other meteorological observations, morning and evening each day, and also for keeping statistics of diseases and deaths. Dr. Berigny of Versailles has in charge a reduction of the observations, and the following are his conclusions on the subject of ozone.

(1.) The more the ozonometric test papers were colored in the open air, the more numerous were the sick that were taken to each of the hospitals. One of these hospitals was situated at the general quarters at Sebastopol (Observatory No. 1), the second at the south border of the Inkerman plateau (Obs. No. 2).

(2.) The higher the temperature the smaller the number of sick entered and also of deaths.

(3.) At the three observatories, the ozone curve was essentially the same; and (4.) the same was true for the temperature.

(5.) At observatory No. 1, the less the ozone, the greater the number of deaths, whilst at observatory No. 2 it was the reverse.

This is almost the only positive result which science and humanity have derived from that destructive war, which has cost so much money and so many lives.

Dynamoscopy.—Dynamoscopy is a new mode of auscultation, directed towards the examination of sounds hitherto not studied. The author,

Dr. Collongues, examines these sounds in case of a deceased person with an instrument with one extremity on the part to be ausculted and the other at the ear. It is with this instrument that Dr. Collongues supposes he is able to detect the evidence of actual death.

He found this evidence in 1854 in the case of a woman attacked with cholera who was not believed to be dead. Examining about the heart with his dynamoscope, he distinguished a crackling sound which continued even to the tenth hour after death. He followed up this trial with others, and has arrived at the following conclusions respecting this sound.

(1.) After the respiration and the beating of the heart have ceased at death, a crackling sound may be heard which he calls "bourdonnement."

(2.) The sound continues from five to ten hours after death.

(3.) It goes on decreasing from the time of death, and is last perceived about the præcordial and epigastric regions.

The results have been confirmed by observations on animals. It hence results that life continues until the cessation of this sound has ceased, and the cessation is a positive sign of death. This observation offers a means of distinguishing *lethargy* from death, as the sound does not cease in lethargy.

On applying the instrument to the extremity of the fingers, a sound of similar kind is heard which varies with the age, sex, state of health, activity or repose. The crackling is more rapid in children than in adults, and still more so than in aged persons. It is more gentle in woman than in man of the same age, and the crackling sounds ("pétillemens") are in general twice as numerous as those of man. There is also a great difference for different temperaments, and for different seasons and climates.

A singular experiment made with the instrument is to hear a faint and agreeable harmony which is made at the extremity of the fingers of a man asleep, whilst when awake there is only a great discordance in the "bourdonnement." Dr. Collongues supposes that these sounds have their seat in the nerves.

Artificial Caoutchouc.—This substance is obtained by the action of chlorid of sulphur on oils. On adding to oils an excess of this chlorid, they become heated and take a consistence more or less viscous; after some days they harden and become friable. With one part of the chlorid to nine of the oil, there is a lively reaction, chlorhydric acid is disengaged, and it is all changed into an elastic substance like sponge which whitens in the water. The products are insoluble in water, alcohol, ether, oils, and sulphuret of carbon; they are attacked neither by ammonia nor by dilute acids, and are not altered at 150° C.

These facts have been recently communicated to the French Academy and they were regarded as new. They were known by myself in 1848, and the following is a brief statement of the remarks which I have made on the subject to the Academy. "In order to protect the glass stopper of a flask containing chlorid of sulphur from incrustation, I put on it a little oil. I was not a little surprised on the next day to find the coating completely solidified. I soon recognized that the solidification had been caused by the chlorid, and that in general, this compound hardened fatty bodies by modifying them more less. Being then engaged in other

researches* I proposed to myself to take up this chance observation at another time, when I learned by a number of Dingler's Polytechnic Journal for 1849 that the fact had also been observed by Mr. Rochleder. The subject having thus lost for me its special interest, I published it without making any claims of priority.

"Since then, this observation has been taken up by Mr. Gaumond, who, by mixing the chlorid of sulphur with the sulphuret of carbon has made of it several interesting applications. He forms a soft elastic paste, with which he prepares the ink-rollers of printing presses. This was in 1852."

At the same session, Mr. Balard communicated the results obtained in his laboratory by a workman, Mr. Perra, temporarily engaged there; this was in 1853. The following are some of the results:

100 parts of linseed oil with 15 to 20 p. c. of chlorid of sulphur gave an elastic product. With 5 p. c. of the chlorid the oil was thickened strongly without hardening; in this state it is soluble in all liquids which dissolve the oils, which is not true of the other products obtained with the chlorid. On mixing a given weight of linseed oil with thirty to forty times its weight of sulphuret of carbon, and then introducing one-fourth of chlorid of sulphur, the product remains liquid for several days. On applying this liquid to glass, wood, or any other solid body, the sulphuret of carbon evaporates immediately and the solid body is found to be covered with a varnish.

The chlorid saturated with sulphur is preferable to the pure chlorid. To succeed in these mixtures, it is necessary to put the chlorid quickly into the oil, and agitate it, in order to obtain a uniform product. By degrees it becomes heated; the oil hardens more or less according to the proportions of the chlorid of sulphur. It is necessary to operate with only small amounts of chlorid and avoid the elevation of the temperature. When the mixture is perfect, the material is thrown on a polished surface, as a plate of glass: after some minutes, it is done. A corner of the pellicle is detached with the point of a knife and immediately the whole is easily removed. Several layers may be added to one another, moisture being avoided at the moment of the operation.

Mr. Perra has in this way made small boxes and the handles of knives. By inserting a metallic cloth between two plates of this hardened oil, he has obtained plates that were quite durable. With some precautions, the plates may be made transparent and unalterable in the air; for this end, it is only needed to place them in a stove in order to expel the excess of chlorid. Cold renders the products hard and brittle.

Mr. Perra has not succeeded in making a substance analogous to hardened caoutchouc. He has colored the material or veined it like marble; and for this purpose the coloring material is mixed with the oil before the chlorid is added.

These products made from vulcanized oil are inconvenient for use, as they retain for a long time a disagreeable odor. They are not acted upon by dilute acids or alkalies. In the concentrated state, the alkalies sapo-

* On the cause of the variation of angles in crystals, and on the isomorphism of homologous compounds. See Comp. Rend. Acad., 1848, and Comp. Rend. Trav. Ch. de Laurent et Gerhardt, 1849.

rify them. At 120° C. they become brown, and at a higher temperature they melt with a black color. For moulding, the material is excellent. It is in a high degree electric, and may be used for making electrical plates or the electrophorus. It readily destroys any tissues to which it may be applied.

Bromid of sulphur has properties analogous to those of the chlorid.

Photochemical experiments.—We have more than once had occasion to speak of Niepce de St. Victor, of the military ranks, who employs his leisure in the useful arts. If it shall be demonstrated that there is a fluid analogous to that of caloric and light, presiding especially over chemical phenomena, Niepce de St. Victor will have had a prominent part in the discovery. But a few months since, he ascertained the fundamental fact that a body which had been exposed to solar radiation could act in the dark at a distance on certain bodies, like light which emanated directly from the sun. The observations were made mostly with a cylinder of white pasteboard. Mr. Niepce has just noticed that the pasteboard that has been exposed to the sun, and then has been preserved in the dark in a cylinder of sheet tin (tinned iron), is still active six months afterward. This action of the chemical fluid calls to mind radiant heat.

Nitrate of uranium has in a high degree the property of magazining the chemical fluid. On exposing to the sun, under a photographic proof, paper impregnated with nitrate of uranium, and then at the end of a quarter of an hour, plunging it into a solution of nitrate of silver in the dark, a positive image immediately appears having the usual maroon tint. To fix it, it is only necessary to wash it with pure water. If the nitrate of silver is replaced by chlorid of gold, the image appears of a deep blue. These pictures resist the action of the cyanid of potassium, even on ebullition; they are therefore far more stable than photographs taken in the ordinary way.

Tartaric acid has this same property, although in a less degree. Heat increases the sensibility of the reaction. For on covering with a plate of iron heated to 50° C. both the pasteboard which bears the impression from the sun and the leaf of sensitive paper prepared with chlorid of silver, the image will appear at the end of a few minutes, while at 0° C. it requires several hours to obtain a faint impression.

One general result of the researches of Mr. Niepce is this, that the bodies which preserve the greatest activity with a dose of the sun are, with the exception of the salts of uranium, those which are the least disposed to fluorescence.

This chemical activity which certain bodies may contract under the influence of the sun's rays or *insolation*, is greater or less according to the nature of the substance; it has its limits; when a substance has reached its maximum of activity continued exposure does not add anything to it.

Paper prepared with the nitrate of uranium changes color in the light and becomes insoluble; in the dark it is decolorized, and it becomes soluble after some hours, to be colored again in the light. It reduces the salts of gold and silver, so much as to become colored and insoluble.

A body rendered active by the sun will transmit this activity by contact in the dark to another body—tartaric acid, for example.

Mr. Niepce proposes to investigate whether the permanent activity communicated to a body by the solar rays is capable of determining the combination of chlorine and hydrogen, and whether it can be acquired in a luminous vacuum. An engraving wet and subjected to the sun reproduces itself on sensitive paper. But if it is covered with some millimeters of water, the effect fails, even with a solution of a salt of uranium or tartaric acid.

After having shown that certain bodies acquire by exposure to the sun, the property of reducing in the dark, salts of gold and silver, Mr. Niepce observes further that the reduction does not take place without the intervention of an organic substance. Paper is very good for this purpose, while no action is obtained if we take, for example the edge of a porcelain plate which has just been broken; on impregnating this edge with a solution of nitrate of uranium, no effect is obtained in the sun; but there is an action if we put on the edge a solution of nitrate of silver, containing a little starch or gum, and then sulphate of iron or gallic acid; a coloration is seen in the part subjected to the sun; it is the same if silver be used in place of uranium.

The reagents which Mr. Niepce employs by preference for demonstrating this action of the light are the salts of gold and silver, tinctures of litmus and turmeric, iodid of potassium for paper prepared with starch. In many substances that have been exposed to the sun the activity communicated is apparent in the insolubility; it is on a similar principle acquired under the sun's action by gelatine containing bichromate of potash, that Mr. Talbot has founded his photoglyphy. Heat and humidity promptly cause the loss of this property.

Mr. Niepce cites many examples in which the same results are obtained on inverting the course of operations; thus, a leaf of paper impregnated with gallic acid and exposed to the sun, treated by iodid of potassium, gives a feeble image which becomes very decided if subjected to nitrate of silver. A sheet of paper impregnated with chlorid of mercury and exposed to the sun gives an image with chlorid of tin, chlorid of sodium, soda, potash, and sulphuret of sodium. In the same manner a sheet impregnated with chlorid of tin, and exposed to the sun, gives an image with sulphuret of sodium, chlorid of mercury, chlorid of gold ($Cl^3\ Au^2$) and nitrate of silver. A multitude of important facts are still to be drawn from the recent works of Mr. Niepce and we shall return to them again.

Reproduction of engravings by means of Phosphorus.—The engraving is exposed to the vapors of phosphorus burning slowly in the air; the black parts alone become impregnated with the vapors; it is then applied to a sheet of sensitive paper prepared with chlorid of silver; after a quarter of an hour of contact, the engraving is represented on the paper by a design formed of phosphuret of silver, which when it is sufficiently decided, resists the action of dilute chemical agents.

The best way of operating consists in placing the engraving in a box in front of a piece of pasteboard whose surface has been rubbed with a stick of phosphorus, and which covers one of the sides of the box. It is necessary to rub the pasteboard with phosphorus at each operation, because if the phosphorus becomes red phosphorus, it produces no effect.

Chemical nomenclature; making of new words.—To French men of science, or at least to those who seek to discover facts and new substances or species, it is a subject of gratulation that a French-and-Greek dictionary has recently been published. This dictionary is issued by the publishing house of Hachette. Its authors are three Greek scholars, of the highest merit, Messrs. Alexandre, Inspector general of the University, Planche and Defauconpret, Professors. There is also a complementary work—a Græco-French Dictionary by Mr. Alexandre alone.

Bibliography.—At MALLET-BACHELIER's, Quai des Augustin, Paris. *Traité d'Optique physique*, par M. BILLET, Prof. in the Faculty of Sciences at Dijon, tome I.—This work is altogether mathematical, and one of the kind has long been needed in France. Prof. Billet, with whom the higher optics is a specialty, has here published the results of 20 years of labor. The volume has already gone into the hands of all opticians and professors of physics.

Cours de Physique de l'Ecole Polytechnique, par M. JAMIN. Tome I, with 270 figures and a steel plate.—Mr. Jamin is Professor in the Ecole Polytechnique, and in this work he presents the programme of the course of physics in this celebrated school. From the range of the work it might well be entitled a General Treatise on Physics, for not only are the different topics profoundly treated, but also experimental demonstrations come to the aid of the theoretical and mathematical.

At HACHETTE's, Rue Pierre Sarazin, Paris.

Résistance des Matériaux, 1 vol. in 8vo., 2d ed.—The first edition of this work appeared in 1853, and has been rapidly exhausted. Before preparing the second, its author, General MORIN, Director of the Conservatory of Arts and Trades, desired to verify by experiment the principal theories, and to this end has made many trials to test the accuracy of the hypotheses admitted in the ordinary theory with regard to the resistance of solids to flexure. He has also experimented on the resistance of sandstone to pressure, on which subject he gives an abstract of the trials made by the French engineer, Mr. Michelot, on the resistance of stones employed for construction at Paris.

Précis d'Agriculture théorique et pratique, par MM. PAYEN and RICHARD. 2 vols. in 8vo.—Among its topics, this work reviews the most recent discoveries on the principal points in the culture of land, besides being an elementary treatise on all departments of agriculture and even Zootechny, a science in which M. Richard is authority, as we had occasion to remark when announcing his "Dictionnaire raisonné d'Agriculture."

Problèmes de Mathématiques et de Physique, par M. MENU DE ST. MESMIN. 1 vol. in 8vo.—This is a volume of exercises prepared with reference to students in the Department of Engineering including Mines, Bridges, Roads, etc. The problems are followed with solutions and explanations, and are illustrated by many figures in the text.

Dictionaire Grec-Français, et Français-Grec. 2 vols., grands in 8vo.—This work is noticed above.

Dictionnaire des Cotemporains, par M. VAPPEREAU, grand in 4° de 1800 pages en 2 colonnes.—In this work, the author proposes to give a biographical notice of the most distinguished cotemporary men in all de-

partments of science, art, industry, literature, politics, and even war. This colossal work remains in the 'state of composition' from the beginning to the end, and therefore open to emendations, until the moment of publication. Supplements will be published as may be required. The whole dictionary is so put together as to admit of modifications, which must be numerous; for the good faith of the author has been more than once surprised.

This dictionary is not addressed only to the French, for men of all lands have a place in it; and the American reader will find a biographical notice of the principal men of the State, Art, Literature and Science in the United States.

Les Philosophes Français au 19e siècle, par TAINE, in 12-de 368 pages. —This work is written with much spirit, and in a style both elegant and well adapted in our view for the scientific criticism it contains.

DESCLOZIÈRES.—*Vie et Inventions de Philippe de Girard*, broch. in 12mo, avec figures.—Philippe de Girard was the inventor of the machine for spinning linen thread, and the author of many other inventions, well exhibited and appreciated in this small work.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On intermitting fluorescence.*—J. MÜLLER has observed in platinocyanid of barium a peculiar phenomenon to which he has given the name of intermitting fluorescence. When a strip of paper is washed with a solution of the salt in such a manner that on evaporation the surface appears covered with a layer of delicate green crystals and then exposed in a dark room to the spectrum produced by a flint glass prism aided by a lens of long focal distance, almost the whole portion on which the blue rays fall appears blue. In this blue portion however, three isolated green fluorescent bands appear. The middle of one of these bands corresponds to Frauenhofer's line G; the two others lie between G and F. The centres of these bands correspond to the wave lengths $0{\cdot}000462^{mm}$, $0{\cdot}000446^{mm}$, $0{\cdot}00430^{mm}$. From this it appears that rays of these wave-lengths produce fluorescence, while those of intermediate wave-lengths produce none. An uninterrupted green fluorescence begins at that portion of the spectrum which corresponds to a wave-length of about $0{\cdot}000410^{mm}$. No similar phenomenon has hitherto been observed.—*Pogg. Ann.*, civ, 649.

2. *On the increase in the resistance to electrical conduction which depends on temperature.*—CLAUSIUS has pointed out a remarkable result deducible from the experiments of Arndtsen on the resistance of metals at different temperatures. Arndtsen had arrived at the result that in the simple metals, with the exception of iron, the resistance increases uniformly with the temperature and that in the different metals the comparative increase is nearly the same. Clausius remarks that Arndtsen's numerical results may be expressed by the formula

$$w_1 = w_0\ (1 + 0{\cdot}00366,\ t),$$

in which w_1 is the resistance at the temperature t, w_0 the resistance at

0° C. From this it would follow that the resistance of the simple metals in the solid state to electric conduction, is nearly proportional to the *absolute temperature.* The author remarks that although this conclusion is not yet fully borne out by experiment, the numbers obtained being only approximate, it may yet be of interest and serve as an inducement to new investigations.—*Pogg. Ann.* civ, 650.

3. *On the expansion of liquids heated above their boiling points.*—THILORIER found in 1835 that liquid carbonic acid between 0° and 30° C., has a mean coefficient of expansion of 0·0142, which is about four times greater than that of air and other gases. Drion has endeavored to generalize this observation, and finds, in fact, that other volatile liquids at temperatures sufficiently above their boiling points, exhibit coefficients of expansion of similar magnitude. The following are the author's results for chlorhydric ether and sulphurous acid. The coefficient of expansion of chlorhydric ether at 0° is according to Pierre 0·00157. According to Drion the apparent expansion of the same liquid is 0·00360 of its volume, at 121° C. upon the average for every degree centigrade. Between 128° and 134° the coefficient is 0·00421 of the volume at 128°, while between 144°·5 and 149°·25 the coefficient is 0·00553 of the volume at 144°·5. The mean expansion of sulphurous acid between 0° and 18° is 0·00193. Between 91° and 99°·5 the coefficient is 0·00368 of the volume at 91°; between 108°·5 and 115°·5 it is 0·00463 of the volume at 108°·5; between 116° and 122° it is 0·00533 of the volume at 116°; between 122° and 127° it is 0·0060 of the volume at 122°. From this it appears that the coefficient of expansion of chlorhydric ether becomes equal to that of a gas at a temperature of about 125° C.; that of sulphurous acid equals that of a gas at about 95° C. Above these temperatures the coefficients increase very rapidly.—*Comptes Rendus*, xlvi, 1235.

4. *On the chemical effects of electric discharges.*—PLÜCKER has published in successive parts, the results of an elaborate and very interesting investigation of electric discharges in tubes containing rarefied gases. For the details we must refer to the original papers, which do not admit of condensation, and content ourselves with giving in the author's own words, the results which are most interesting to chemists.

I. Certain gases (oxygen, chlorine, bromine and vapor of iodine,) combine more or less slowly with the platinum of the negative electrode, and the resulting compounds are deposited upon the surrounding sides of the glass tube. When the gases are pure we approximate in this manner to a perfect vacuum.

II. Gases which are composed of two simple gases (vapor of water, ammonia, protoxyd of nitrogen, deutoxyd of nitrogen, nitrous acid,) are immediately separated into their components, and then remain unchanged, if they do not (as ammonia) unite with the platinum. If one of the gases be oxygen (as in steam and the different oxyds of nitrogen) this gradually disappears and only the other gas remains.

III. When the gases are composed of oxygen and a solid simple substance, complete decomposition by the current takes place but slowly, the oxygen going to the platinum of the negative electrode, (sulphurous acid, carbonic oxyd, carbonic acid). Carbonic acid at first splits instantly

into the lower gaseous oxyd and into free oxygen, which combines gradually with the platinum. Carbonic oxyd gas is then slowly decomposed by the combination of its oxygen with the negative electrode. The results above mentioned, were obtained by means of the so-called Geissler's tubes, which are simply glass tubes of various forms containing rarefied gases, and provided with platinum wires fused into the glass. The electric currents were partly derived from the electric machine, and partly from Ruhmkorff's apparatus. Finally, the results themselves are directly deduced from the prismatic analysis of the light of the simple and compound gases, the spectrum obtained being simple, or composed of two distinct and superposed spectra, according as the discharge passes through a simple gas or a mixture of two.—*Pogg. Ann.*, cv, 67. W. G.

5. *On a new Law of Binocular Vision;* by the Rev. J. DINGLE, (Proc. Brit. Assoc., Ath., No. 1615).—The object of the law in question is to obviate the imperfect vision which would sometimes arise from the difference of the pictures in the two eyes. In some cases this difference would lead to great inconvenience and confusion. It sometimes happens, for instance, that in looking at a field of view at some distance, objects considerably nearer are so interposed as to present themselves in the picture formed in one eye and not in the other. Thus, in looking at a landscape, if the finger or any other object is held before one eye, the image of it from the one retina is superposed in the *sensorium* on a part of the landscape formed in the other eye. On mere physical principles, this might be expected to blot out or greatly confuse that part of the landscape upon which it was placed; but upon trial this is not found to be the case, as that part is merely a little dimmer than the rest from being seen only with one eye, but is equally distinct and as truly colored.

By various experiments the author had ascertained that this was the result of a peculiar power of the will, by means of which the mind is enabled, when two different images are superposed in the *sensorium*, to select whichever it pleases, to bring that object into view, and entirely to obliterate the other,—it sees, in fact, whichever it wills to see, and the other image, simply by being neglected, becomes invisible. In ordinary vision, the determination of the image to be seen is effected by the same act of the will which determines the position of the optic axes; but by certain arrangements which were indicated both images may be made to have the same relation to the optic axes; and as the predisposition to select one or the other is thus obviated, it is made indifferent to the mind which of the two images that occupy the same place in the *sensorium* it shall see. When these arrangements are made, it is found that mere efforts of the will can easily bring either the one or the other into view. The importance of this law, which enables the mind to select its image, was pointed out in different cases of ordinary vision. It obviates the difficulty already adverted to, of having two different pictures on the same spot; it has not improbably an important influence in producing the general stereoscopic effect; it also, to some extent, remedies the effect of squinting, by obliterating the picture in the imperfect eye, which could not be else done without shutting it. The effect of the law, in some extraordinary cases, was also noticed, especially in the power of the will to fix images on the sight, as Sir Isaac Newton instances in his own case

(see his life by Sir David Brewster). The author pointed out the great interest of the subject, not only in its practical aspect, but also as having an important bearing on the connexion between mind and matter.

Prof. Stevelly said that in reference to these permanent impressions on the retina so well described in the very interesting letter from Sir Isaac Newton which had been read, he wished to mention a circumstance which occurred to himself this summer, and which he was entirely unable to account for on any optical or physiological principle with which he was acquainted. At the close of last college session he had been in weak health, and had gone out to his brother-in-law's seat in the country for a few weeks. While there he had become greatly interested in the economy and habits of the bees. "One morning, soon after breakfast, the servant came in to say, that one of the hives was just beginning to swarm. The morning was a beautifully clear, sunny one, and I stood gazing at the insects, as they appeared projected against the bright sky, rapidly and uneasily coursing hither and thither in most curious yet regular confusion, the drones making a humming noise much louder and sharper than the workers, from whom also they were easily distinguished by their size; but all appearing much larger in their rapid flights than their true size. In the evening as it grew dark, I again went out to see the bee-hive, into which the swarm had been collected, removed to its stand; soon after I was much surprised to see, as I thought, multitudes of large flies coursing about in the air. I mentioned it to my sister-in-law, who said I must be mistaken, as she had never seen an evening on which so few flies were abroad. Soon after, when I retired to my chamber, and knelt to my prayers before going to rest, I was surprised to see coursing back and forward, between me and the wall, what I now recognized as the swarm of bees, the drones quite easily distinguishable from the workers, and all in rapid whirling motion as in the morning. This scene continued to be present to me as long as I remained awake, and occasionally when I awoke in the night, nor had it entirely faded away by next night, although much less vivid. This was the first instance I had ever heard of moving impressions having become permanently impressed on the retina, nor can I give the slightest guess at the *modus operandi* of the nerve. Notices of fixed impressions, particularly after having been dazzled, are now common enough. The Rev. Dr. Scoresby, at the late meeting at Liverpool, had given a detailed account of some which had presented themselves to him; and a very curious one had occurred to me some years since. I was walking down the streets of Belfast with Sir John Macneill, the eminent engineer, when he said to me—'what has become of my old friend Green, who kept that shop; I see new people have got it.' Turning suddenly to look at the shop indicated, I was completely dazzled by the bright reflexion of the sun shining on the new brass-plate under the window of the shop, so that for some seconds I could see nothing. As we walked on I soon observed before me in the air the words 'J. Johnstone & Co.,' in blood-red characters, which soon, however, changed to other colors. With an exclamation of surprise I stated the fact, and we turned back to see whether or not this was really the inscription on the brass-plate, and found that it was. The optical account of this was simple enough. The retina had been partially paralysed from

the intense light reflected from the plate, but as I had turned with pain from it instantly, the part corresponding to the black letters on the plate had escaped, and as I walked on the red strong light reflected from surrounding objects on this part became contracted with the darkness, as yet showing itself on all the surrounding parts of the disordered retina; as the retina recovered its tone other colors in succession took possession of the place which at first had been red. Sir J. Macneill then told me that when first he had gone to reside in London, a murder had been found out by a similar circumstance. The murderer, then unknown, had been dazzled by the reflexion of the sun from a bucket of water, which another man was carrying before him, and soon after seeing in the air what he took for a bucketfull of blood going before him, he was seized with such horror that he declared himself the murderer, and disclosed such facts as brought the crime home to him, so that he was convicted and executed."

II. GEOLOGY.

1. *A record of Earthquakes, kept at Hilo, Hawaii;* by S. C. Lyman, (from a letter addressed to Dr. C. F. Winslow, and by him communicated for this Journal).—*June*, 1833. Two slight shocks during the month.

Oct. 3, 1833.—Two shocks in the night, one quite heavy.

Oct. 13.—A shock at 3 o'clock, P. M., motion quick, up and down.

Feb. 19, 1834.—At 6 P. M. there was a slight shaking of the earth which was almost instantaneously followed by a shock so heavy as to upset some things in the house, throw the cream off from milk standing in pans, and throw water out of a pitcher standing in a wash-bowl. At 9 o'clock in the evening there was again a shaking of the earth which lasted only a few seconds.

May 14.—A heavy shock between 2 and 3 P. M.

Aug. 3.—One at about 4 o'clock, A. M., so heavy as to waken people, and cause them some alarm.

March 23, 1835.—One slight shock at 9 A. M.

March 26.—Three shocks following each other in quick succession at 25 minutes past 6 o'clock A. M.

July 21.—Three shocks during the day.

Sept. 6.—One shock at 2 or 3 o'clock A. M.

June 20, 1837.—A smart shock at 20 minutes before 7 P. M.

Jan. 12, 1838.—A smart shock some time after midnight.

Jan. 29.—Three shocks in pretty quick succession a little past 10 o'clock P. M. The first two heavy, the last slight.

July 9.—A slight shock between 8 and 9 o'clock A. M.

Oct. 16.—A jar merely, accompanied with a noise resembling the discharge of distant cannon.

Nov. 5.—Three shocks during the day, one in the forenoon and two in the afternoon.

Nov. 6.—One shock, a few minutes before 10 A. M.

Nov. 7.—A smart shock at midnight, another at twenty minutes past 3, and another about 4 o'clock A. M.

Nov. 8.—Several shocks during the day, and twelve distinct ones during the night. There were frequent shocks during the day and night for

five days following, and then occasional ones during the month, none of them heavy, some of them accompanied by a rumbling sound, others by a noise like the rushing of water by a ship. There was one quite heavy shock, but I do not recollect the time.

Dec. 4.—A distinct though not heavy shock.

Dec. 9.—One shock at 40 minutes before 12 at noon.

Dec. 10.—One shock at 4 o'clock, A. M.

Dec. 12.—A severe shock at 1 o'clock P. M. Stone walls were thrown down, and plastering a good deal cracked, but no other damage done.

April 7, 1839.—A pretty smart shock at midday.

Feb. 1, 1840.—A severe shock at half past 1 P. M.

May 5.—A slight shock at 4 P. M.

Sept. —.—A shock at 10 P. M.

Oct. 14.—A slight shock between 8 and 9 o'clock P. M.

Dec. 18.—Two smart shocks about 5 A. M., waking us from our slumbers.

March 11, 1841.—Two shocks, one at fifteen minutes before 1, the other at 20 minutes before 2 P. M. The motion was up and down, gentle and easy.

April 5.—A smart shock at 15 minutes past 1 P. M., undulations north and south.

April 7.—At 11¾ P. M. This was the most severe shock we have ever felt. Stone walls thrown down, plastering cracked, and chimney also, milk was thrown out of the pans and water out of a pail a little more than half full. Motion undulating north and south. In just one hour there was a trembling of the earth, and after another hour another jar.

May 28.—A shock at half past 7 P. M., not heavy.

June 26.—A shock in the night.

July 3.—A shock between 5 and 6 A. M.

Sept. —.—A smart shock in the night.

Nov. 28.—A shock in the night.

Feb. 14, 1842.—A shock at 5 o'clock A. M.

May 15.—A shock in the night.

Aug. 31.—A shock at half past 9 P. M., not heavy.

Nov. 9.—A shock in the night so heavy as to awaken us.

March 8, 1843.—A shock at 7 o'clock P. M.

April 27.—A shock in the night.

July —.—Two shocks during the month. One in the night, or P. M.

Dec. 15.—A shock at 10 A. M.

Feb. 18, 1844.—A severe shock at half past 6 P. M.

Sept. 1.—A heavy shock between 7 and 8 A. M.

Dec. 21, 1845.—A moderate shock in the night.

Feb. 14, 1846.—A slight shock at 7 A. M.

June 15.—A moderate shock in the night.

June 24.—Ditto.

March 29, 1847.—A shock between 9 and 10 A. M.

Oct. 4.—A heavy shock about 3 o'clock P. M.

Feb. —, 1848.—A heavy shock at 5 o'clock P. M.

April 19.—Two slight shocks about 8 P. M.

July 9.—A severe and protracted shock at 4¾ A. M.

Dec. 5.—A slight shock at 8½ o'clock A. M.

In 1849, none.

In 1850, only two shocks during the year.

Jan. 12, 1851.—A smart shock at 7 P. M. Premonitory shock, very distinct.

May 4.—A moderate shock after midnight.

May 11.—A slight shock at 2 o'clock A. M.

July 14.—A heavy shock at 20 minutes past 10 A. M.

Aug. 21.—A moderate shock towards morning.

March 31, 1852.—A very severe shock at 1½ P. M.

Oct. 19.—A smart shock at 4¾ A. M.

March 2, 1853.—A smart shock at 5 o'clock P. M.

March 8.—A slight shock.

March 11.—A smart shock at 4½ o'clock A. M.

Aug. 26, 1854.—A smart shock at 4 o'clock P. M.

Oct. 29.—A smart shock at about 8 P. M. Premonitory, distinct.

March 18, 1855.—A smart shock at 8½ P. M. Vibrations continuing several seconds.

May 24.—A protracted tolerably smart shock at about 9 A. M.

June —.—A smart shock at 4½ P. M.

Aug. 3.—A tolerably smart shock at 8½ P. M. Motion up and down.

Sept. 17.—A shock at 8 A. M.

Nov. 2.—A smart shock at 7 A. M.

Jan. 8, 1856.—A smart shock at 4 o'clock A. M.

July 8, 1857.—A slight shock at 5½ o'clock, A. M.

July 30.—A severe shock at 1 A. M. Motion undulatory.

Aug. 30.—A slight shock at 1½ P. M.

Sept. 9.—A short smart shock at 9 o'clock A. M.

March, 1858.—One slight shock, time not recorded.

April —.—A protracted and rather heavy shock in the night.

June 8.—A slight shock at 3 P. M.

July 5.—A smart shock or jar at 2 A. M.

This record has been kept simply for my own gratification, and consequently is not in as good a form as it might have been could I have known that it would ever have been needed for scientific purposes. As a general thing I noted down the earthquakes as they occurred. When they have come in the night I have not always known the precise hour, and when I have been sick the day of the month has sometimes been forgotten. This must account for the imperfect manner in which my record has been kept. I shall endeavor to be more particular in future.

I would here remark that our earthquakes are never very protracted, seldom lasting over a few seconds, and they are seldom violent, though generally sufficiently so to shake our nerves.

Hilo, Hawaii, Sept. 11, 1858.

2. *Hadrosaurus Foulkii, a new Saurian from the Cretaceous of New Jersey, related to the Iguanodon*, (from the Proceedings of the Acad. Nat. Sci., Philad., 1858, p. 213.)—Mr. Wm. Parker Foulke made a statement respecting the fossil bones, shells and wood presented by him to the Academy this evening.

Passing the summer and autumn at Haddonfield, Camden County, New Jersey, Mr. Foulke learned that one of his neighbors, Mr. John E.

Hopkins, while digging marl upon his farm, about twenty years ago, had found some bones. These were described as vertebræ, and as being of large size, and very numerous. Mr. Hopkins being young at the time of the discovery, and not specially interested in such subjects had permitted visitors to carry away the fossils; so that none remained in his own possession, nor could he remember the names of any of the persons by whom the vertebræ had been taken. According to his recollection, no head had been found, nor any other bones than those of the spine, except one, which was said by him to have resembled in general respects, a "shoulder blade." It appeared then, not improbable that upon digging around the old pit, (which was sixteen feet long and eight feet wide,) a head, or at least a portion of one containing teeth, might be obtained. Considering the geological age of the formation upon which Haddonfield stands, and that specimens of Mosasaurus had been discovered in places not very remote from the village, there appeared sufficient motive for exploration. Mr. Hopkins with an intelligent appreciation of the object proposed, gave to Mr. Foulke, with prompt liberality, permission to dig in any part of the farm, and to take away whatever fossils might be thus procured. There was some difficulty in ascertaining the place of the old excavation. It had been made in the bed of a narrow ravine, in which a brook flows eastwardly into the south branch of Cooper's Creek; but the pit had long since been filled to the common level of the bed, and it was in like manner overgrown with grass, shrubs, and young trees, so as to be undistinguishable by the eye. After conference with one of the diggers who had been employed at the time of the discovery, (whose indication proved to be inaccurate,) and after a careful survey of the vicinage by Mr. Hopkins, a party of experienced marl diggers were set at work; and after one day's preliminary trial, the eastern side of the old pit was detected. In conformity with Mr. Hopkins's recollection of the manner in which the vertebræ lay, the party of diggers was shifted to the western side of the old pit. The superficial deposit overlying the marl here, was only about four feet thick; the ravine being between twenty and thirty feet deep. At nearly four feet further depth, a thin stratum of decomposed shells was passed; and at about two feet below this, overlying and intermixed with another stratum of shells, the workmen came upon a pile of bones—the same now before the Academy. The total depth from the surface was between nine and ten feet. * * *

Dr. Leidy stated that the bones, mentioned in the remarks of Mr. Foulke, obtained from the marl of Mr. Hopkins's farm, near Haddonfield, New Jersey, and now exposed to the view of the Society, were those of a huge herbivorous saurian. The animal was closely allied to the great extinct *Iguanodon* of the Wealden and Lower Greensand deposits of Europe; the genus is, however, different, and for it the name of *Hadrosaurus*, is proposed.

Besides a number of small fragments, the bones consist of twenty-eight vertebræ, mostly with their processes broken away; a humerus, a radius and an ulna, complete; an ilium and a pubic bone, imperfect; a femur, a tibia and a fibula; two metatarsal bones and a first phalanx, complete. There are also in the collection nine teeth and a small fragment of the lower jaw.

The bones are ebony black, from the infiltration of iron, and are exceedingly heavy. Their texture is firm and well preserved; and they are neither crushed nor water rolled. In association with them, besides the shells and wood, were found several teeth of *Odontaspis* and *Enchodus*.

Most of the specimens of teeth of the *Hadrosaurus* appear to have belonged to the lower jaw. These, when unworn and perfect, are about two inches long, and of all known teeth mostly resemble those of the *Iguanodon*. They have a demi-conoidal crown, with a lozenge-shaped enamel surface directed inwardly, and divided by a prominent median carina. The upper borders of this surface are provided with short, transverse, tuberculated ridges. The body of the crown outwardly is paraboloid in transverse section, and is prolonged into a laterally compressed conoidal fang. As the teeth were worn away from the summit, their gradually expanding triturating surface sloped downward and outward. This surface is shield-like in outline, is bordered by enamel internally, and crossed by a slightly elevated crucial ridge with diverging branchlets. The ridge, resulting from the latter ossification of the dental pulp, is harder than the surrounding dentine, and is adapted to retain a rough triturating surface. The sides and bottoms of the teeth exhibit the impressions of lateral and inferior successors, and appear to indicate that the teeth in use, together with those more or less developed within the jaw, had a quincuncial arrangement.

Two of the specimens of teeth perhaps belong to the upper jaw. They differ from the others in the extraordinary degree of development of the median carina of the crown. The enamelled surface was perhaps directed in a reverse manner to that of the lower teeth; that is to say, outwardly. It is likewise lozenge-like in outline, and tuberculated at the lower borders. The body of the crown inwardly is half oval in section. The fang for more than half its width is prolonged from the carina of the crown. These teeth also exhibit the impress of successors holding the same relative position with one another as in the lower teeth.

The fragment of the lower jaw is a portion of the left dentary bone, and is three inches in depth. It has an outer parapet wall about two inches high, with deep vertical grooves for the support of the teeth. No corresponding wall appears to have existed on the inner side of the latter.

The cervical vertebræ have their bodies prominently convex in front and deeply concave behind, and would appear to indicate that Mantell was correct in assigning similar vertebræ, found in the Wealden deposits of England, to the *Iguanodon*. Three cervical vertebræ, suspected to be the third, fourth, and fifth, are two and a half inches long at the sides.

Five succeeding vertebræ, not immediately conjoining the ones just mentioned, and supposed to be anterior dorsals, likewise have convexo-concave bodies. At the sides of the latter they are from 3 to 3½ inches long, and posteriorly are 3½ inches wide. The sides of their arch present a deep pit for the articulation of a rib; but no articular mark is perceptible at the sides of the bodies. Two other vertebræ, perhaps posterior dorsals, have the bodies slightly prominent in front and slightly concave behind; and they are 3½ inches long at the sides, and 4¾ inches wide posteriorly.

The caudal vertebræ possess articular surfaces for chevron bones; and the specimens we possess, from different parts of the tail, give the following succession of measurements of their bodies: length 2½ inches, breadth 5 inches; length 3 inches, breadth 4½ inches; length 3 inches, breadth 3½ inches; length 2¾ inches, breadth 2½ inches; length 2½ inches, breadth 1¾ inches. From the gradation of size of seventeen specimens in the collection, it may be estimated that there were originally about fifty vertebræ to the tail. This number may be too great by about ten, but certainly not more.

A caudal vertebra from near the middle of the tail has its arch and spinous process complete. The two latter together measure 11 inches long from the body, which is 4½ inches deep. The addition of a chevron bone would indicate the tail of the animal, at its middle, to have been between one and a half and two feet in depth.

The *humerus* is perfect, and is 23 inches long. Its breadth at the tuberosities, between which the head projects midway, is 7 inches. The shaft above is compressed from without inwardly; its lower part is cylindroid, and near the middle of the bone measures 9¾ inches in circumference. At the condyles the transverse diameter is 5½ inches. Only a very short and narrow medullary cavity occupies the centre of the shaft.

Both bones of the fore-arm are solid. The *ulna* is 23 inches long, and 7 inches in circumference at the middle. The *radius* is 20 inches long, and 6 inches in circumference at the middle.

A very great disproportion exists between the bones of the fore and hinder extremities. So much is this the case, that I was at first inclined to believe they belonged to different animals. The disproportion is even greater than in the *Iguanodon*, as indicated by comparison with the remains of an individual of the latter, in the British Museum, known as the Maidstone specimen.

The *ilium* has its two extremities broken away, and in its present condition is 27 inches long. Its sacral articular surface is 12 inches long by three inches thick. The breadth of the bone, opposite the latter surface, is from 7 to 9 inches. A bone, which I suspect to be the *pubic*, but which appears to correspond with that of the Maidstone *Iguanodon* described as the clavicle, is 26 inches long in its present state; one end being broken away. The remaining pubic extremity is 10½ inches wide.

The *thigh bone* is 40 inches long; its breadth at the head and adjoining trochanter is 9 inches; its breadth at the condyles is 8 inches; and the antero-posterior diameter of the internal condyle is 10 inches. The shaft is quadrate, and provided at its middle portion internally with a large trochanter. The circumference of the shaft just above the latter is 17 inches; just below it, 15 inches. The condyles in front enclose a large foramen terminating a groove descending from the shaft. Posteriorly, at the bottom of the intervening notch, they enclose a smaller foramen. The medullary cavity is of large size, and extends about half the length of the shaft through its middle portion.

The *tibia* is 36½ inches long; its breadth at the upper part is 11 inches; and its breadth below is 10 inches. Its shaft is narrow and cylindroid at the middle, where it measures 11¾ inches in circumference.

From this position it rapidly expands towards the two extremities of the bone. The medullary cavity is very short and narrow.

The two *metatarsal bones* are of robust proportions and are each about 11 inches long. The *proximal phalanx* of a toe is 6 inches long, and 5½ inches broad at base.

If we estimate the number of vertebræ of the trunk of *Hadrosaurus*, to have been the same as in the recent Crocodile and Iguana; the number of sacral vertebræ to have been the same as in the *Iguanodon*; and the number of caudal vertebræ to have been fifty; the whole number of vertebræ would have been eighty. A calculation of the length of the specimens of vertebræ in our possession, with a proper allowance of separation by intervertebral fibro-cartilages, and an addition of two and a half feet as an estimate of the length of the head, would give, as the total length of the animal, about *twenty-five* feet.

The great disproportion of size between the fore and back parts of the skeleton of *Hadrosaurus*, leads me to suspect that this great extinct herbivorous lizard may have been in the habit of browsing, sustaining itself, kangaroo-like, in an erect position on its back extremities and tail. As we, however, frequently observe a great disproportion between the corresponding parts of the body of recent and well known extinct saurians, without any tendency to assume such a position as that mentioned, it is not improbable that *Hadrosaurus* retained the ordinary prostrate condition, progressing in the manner which has been suspected to have been the case in the extinct batrachian of an earlier period, the *Labyrinthodon*.

Hadrosaurus was most probably amphibious; and though its remains were obtained from a marine deposit, the rarity of them in the latter leads us to suppose that those in our possession had been carried down the current of a river, upon whose banks the animal lived.

Occasionally uncharacteristic fragments of huge bones have been found in the green sand of New Jersey, (of which we have several in the collection of the Academy,) which I suspect to belong to *Hadrosaurus*. One of these specimens exposed to the view of the members, indicates a much larger individual than the one whose remains have been presented this evening.

The species I would respectfully propose to dedicate to our fellow member, W. Parker Foulke, than whom none of our number is more zealous in the advancement of the great objects of this Academy.

3. *Ichnology of New England:* A Report on the Sandstone of the Connecticut Valley, especially its Fossil Footmarks, made to the Government of the Commonwealth of Massachusetts by Edward Hitchcock, Professor in Amherst College. 220 pages 4to, with 60 quarto plates.—Professor Hitchcock has here given us a revision of his labors on the subject of the Connecticut River Footmarks, in which he has so long and successfully labored, and, besides, has added a large amount of new material and many fine plates in its illustration. The volume opens with a bibliography containing a list of all publications on American Fossil Footprints. The characters, conditions, and origin of the strata are then discussed, and following these pages, the descriptions of the various fossil imprints.

On the age of the sandstone Prof. Hitchcock concludes: that the upper half of the sandstone,—that east of the trap range of Mount Tom,

—is not older than the Lias; and that the Virginia and North Carolina beds are of equivalent age; the lower half of the same sandstone, which may be a mile in thickness, according to the measurements of Prof. H., are thick enough to embrace the Triassic and Permian; but no evidence has been obtained that the Permian is represented.

Since the discovery of the Permian in the west as a direct continuation of the Carboniferous beds, and as the closing part properly of the Carboniferous system, it has become more apparent, we think, that the beds on the Atlantic border from the Connecticut valley to North Carolina, belong to a later period. The elevation of the Appalachian mountains appears to have closed the Palæozoic era, and thus separates the Permian period, the last of the Carboniferous age, from the Triassic, the first of the Reptilian. The observations of Prof. Hitchcock tend to confirm this view, for the rocks all appear to belong to one system: the fossils of the upper half are as recent probably as Lias; and no trace of a Permian species has been found in any of the beds.

The footprints are referred to Marsupialoid animals (5 species); Birds (31 species); Ornithoid reptiles, or reptiles walking on their posterior feet (12); Lizards (17); Batrachians (16); Chelonians (8); Fishes (4); Crustaceans, Myriapods and Insects (19); Annelids (10)—in all 123 species, more than double the number announced ten years since. The reference of some of these species to the special division in which they occur is still quite doubtful, as Professor Hitchcock states, especially the Chelonian and Marsupialoid tracks. It is not possible to present the arguments respecting them satisfactorily in a brief notice, and they would be imperfectly appreciated without figures; we therefore refer our readers to the work. The question whether any of the tracks were made by birds has seriously come up, since it has been found that some species (placed among the Marsupialoids in the work, but probably Reptilian) had 3-toed bird-like hind feet, and hand-like fore feet. The descriptions of the species are given with much detail and illustrated by characteristic figures, which enable any that are interested to pursue the subject and work out their own conclusions, where those of the author are not deemed satisfactory. It is quite possible that some of the genera of reptiles are identical with those that have been made out from fossils in Europe. Much is to be learned respecting the tracks of living animals, and the variations for running, walking and standing, before the subject will be exhausted.

The Ichnological Cabinet at Amherst contains a magnificent display of specimens, and if Professor Hitchcock had done nothing more than collect this cabinet, he would have made his mark on the science of geology. In pronouncing the display magnificent we speak advisedly. The Cabinet is by no means fairly treated in a sketch on one of the plates. The hall is 100 feet long and 30 wide; and it is filled from one end to the other with slabs of various sizes, some eight feet and upwards in length. Of the huge Brontozoa and Otozoa there are many specimens; and one series of the latter of eleven tracks covers a slab 30 feet long. The hand-like hind feet of the Otozoum are 20 inches long. There are a few tracks of the fore-feet of this biped batrachian (?) which are a little less than half the length of the hind feet; they show that the ani-

mal sometimes brought its anterior limbs to the ground though generally walking on the posterior pair.

The delicate tracks of insects or crustaceans are also remarkable. There is a specimen with impressions of what appears to be a neuropterous larve, although of doubtful relations. The Cabinet contains specimens of all the species that have been discovered in the Connecticut valley. The number of tracks on all the specimens collectively is not less than 8000, averaging 68 tracks for each species.

4. *Geological Survey of Canada.* Report of Progress for 1857. 240 pp., 8vo. Toronto, 1858. Sir W. E. LOGAN, Geologist.—This valuable Report includes notices of the Laurentian rocks about the mouths of the French River, the Huronian and other rocks of Echo Lake, and the limestone of Bruce Mines, by A. Murray, Esq.; on the Magdalen river and Lake St. John and its deposits, by James Richardson; on the modern fauna of some localities, by R. Bell; on Canadian Graptolites, by James Hall; Palæontological Report by E. Billings; on the composition of some Dolomites, and the origin of magnesian limestone, and on Fish manure, by T. S. Hunt; and an abstract of telegraphic observations for longitude, by Lieut. E. D. Ashe, R.N., with maps, and wood-cuts illustrating the different topics.

Mr. Richardson states in his report on Lake St. John, that recent shells (Saxicava rugosa) occur on Belle river half a mile below the falls, (near lat. $48\frac{1}{2}°$ and long. $71\frac{1}{2}°$,) at a height of probably 200 to 300 feet above the sea; also on River St. Alphonse, about four miles above its entrance into the upper part of Ha-Ha Bay, about 150 feet above the sea. The recent researches of Mr. Hall on Graptolites have already been noticed in this Journal. Mr. Billings describes new species of corals, and new genera and species of bivalves from the Silurian of Canada, illustrating several of the latter by figures; and besides he presents important comparisons between the rocks of Canada and New York. The researches of Prof. Hunt on dolomites are of much interest, and we propose to cite from them in another number.

5. *The Quarterly Journal of the Geological Society of London*, vol. xiv, Part 4, No. 56.—This new number contains the conclusion of the annual address of the President, also the important papers reviewing the Geology of the United States by Dr. J. J. Bigsby, (which, were it not for their great length, we should be pleased to reproduce in this Journal,) and a paper by Mr. H. C. Sorby on the microscopic structure of some crystals, besides other shorter papers.

We cite here the conclusions to which Dr. Bigsby has arrived, without wishing to endorse all as they stand. They relate to the central Palæozoic basin or area of Middle North America. They are in part similar to what has before been presented in this Journal and elsewhere, by other writers.

1. That, whatever may be the case elsewhere, the Silurian and Devonian systems of New York are parts of one connected and harmonious period—the product of successive and varying Neptunian agencies, operating in waters which deepened westward from the Atlantic, and southwards from the Laurentine chain on the north.

2. That from the Catskill group (Old Red Sandstone) downwards through the whole series, to the Potsdam Sandstone, there is perfect and close conformability, and no such unwonted change in fossil life as to constitute a *systematic* break, except at one place—the Oriskany Sandstone, the base of the Devonian in New York,—there being no break of like importance at the Oneida conglomerate period, contrary to an opinion towards which able geologists are now inclining,—an opinion which leads them to consider the break at the Oneida conglomerate as systematic.

3. All the palæozoic groups of New York slowly pass one into the other by gradation of mineral and organic characters, with easily explained exceptions.

4. The palæozoic strata of New York are comparatively thin. They seem to have lost in thickness what they have gained in extension.

5. De Verneuil rightly divides the New York groups into two great classes,—the "constant" and the "local." Among the former are Potsdam Sandstone, Trenton Limestone, and Niagara. Among the latter are the four lower Helderbergs, and perhaps Oneida conglomerate, &c. This is a useful division.

6. That it is both convenient and natural to divide the Silurian and Devonian systems of this State each into three stages,—the division being based on change of sediment and their fossil contents.

7. The Middle Silurian stage is a period of especial transition—from the coarseness of some of its sediments, from their innumerable and minute alternations, and from the organic poverty prevailing.

8. That the presence of Oneida conglomerate in New York does not necessitate a change of name for all the strata below it (of "Cambrian" for instance;) because a conglomerate does not always indicate *systematic* change,—not even if there be volcanic intercalation, provided there is conformableness, and some community of fossils.

The Oneida conglomerate seems to be local, is supernumerary, and only found at present on the east of Middle North America.

9. The hardening and crystallizing effect of metamorphism is seen only in the neighborhood of hypogene rocks.

10. The New York basin exhibits few uplifts, and those of limited magnitude; no uplifts dividing it into a series of deep basins contained in hypogene beds, as in Bohemia, Wales, &c. Neither has it sheets of alternating volcanic grit (conformable,) save in the Potsdam rock on Lake Superior.

This basin has a "lay" or position of its own, as a number of undulating sheets of sediment, dipping slightly to the southwest, here and there pierced by a peak of crystalline rock, and in certain regions raised into three broad low domes of great length.

11. The sedimentary rocks of this basin have submitted to two kinds of plutonic disturbance, independent of each other, and acting at distant intervals: 1st, that of secular or slow oscillation during deposition; 2nd, that of disturbance arising from paroxysmal uplifts long after their completion.

12. The whole Silurian and Devonian series of strata having, during deposition, sunk to the depth of 13,300 feet, it is submitted as a query whether it does not seem necessary to suppose that they were elevated

into their present position by the post-carboniferous uplift,—such agency being sufficient to produce all the observed phenomena, and the effects diminishing westwards from the central line of disturbance. No other agency is known to me, although hinted at by [some] American geologists.

13. It is a remarkable fact that brine-springs exist in considerable quantity in the middle stage of the Silurian system, a group or two below the Onondaga salt-springs of the upper stage, and three palæozoic systems below any salt deposits in Europe.

14. That the form and direction of the five great Canadian lakes are not due originally and mainly to the passage of loaded waters over their site, but that they follow the outcrops of their containing sedimentary rocks; changes in shape and size having, nevertheless, occurred since.

15. The contours of the valley of the St. Lawrence generally (to which much of New York belongs), and its increasing elevation southwestwards, inland from Montreal, are due to the successive altitudes assumed westward, in slopes and plateaux, by the Silurian and Devonian strata, the lowest or most ancient being on the east. This is beautifully evidenced in the rocks forming the basins of the great Canadian lakes.

16. That some of the groups, during and after deposition, were subatmospheric, presenting the conditions of dry land and shallow waters for long and varying periods,—and that, together with the marine life they supported, they enjoyed the influences of the sun and other meteorological agencies. This is indicated by animal tracks, sun-cracks on ancient shores, the short ripple-marks of a chopped sea, impressions of reeds waving in running water, and by the presence of bog-iron-ore. This is conformable with what took place in the carboniferous, permian, triassic, liassic, oolitic, wealden, and later periods. Denudations also occurred to most of the groups to a large extent.

17. That in New York, as elsewhere, there is an intimate connexion between fossils and their sediment or habitat. The calcareocolous animals are always found in limestone more or less pure, and the arenicolous in sandstone more or less pure,—with exceptions, such as usually happen with respect to locomotive animals. The calcareocolous are everywhere the most numerous. It is true that molluscs are the principal agents in the deposition of calcareous sea bottoms; but these latter greatly favor afterwards the multiplication of individuals.

18. That the iron-ore which we so frequently see investing invertebrate remains, had access to them after their death and sepulture.

19. Every group, as established by the State Geologists of New York, is a distinct centre of life,—a separate realm or community of animated beings, which may be called epochal, so marked are the differences.

The majority of these existences always perished at the end of the group when certain deposits ceased, because the new sediment, with its new and peculiar flora (and for other reasons,) was only able to nourish a few, if any, of the old molluscs.

20. In New York the species of fucoids occupy and are typical of only one group.

21. All the individual existences are perfect at once, from the earliest dawn of life, in their organization and social relations.

22. It is a great thought, that throughout the incalculably long succession of fossiliferous deposits, palæozoic or more modern, all animal and vegetable life was constructed upon the same idea of innervation, organs of sense, supply and waste, fecundation, &c.

23. There is another kind of life-centre—the geographic, belonging to one and the same group. This forms numerous separate provinces linked together by a few common fossils, and displaying extraordinary variety. This principle or regulation is carried out abundantly everywhere. Bohemia and Scandinavia have scarcely a Silurian fossil in common. One half of the Russian and Irish fossils, and two thirds of those of New York, are new and peculiar. Even the east and west sides of the small districts in Wales and England investigated by Prof. Philips, differ remarkably in their population. We see this in the American Tertiaries and in the recent seas.

24. Contrary to the opinion of Mr. D. Sharpe, the mollusc having the greatest vertical range has the greatest horizontal extension, being found in the most distant regions.

25. There is no evidence of multiplication of species by transmutation.

26. Fossils may be contemporaneous in geological age, without being contemporaneous *in time* as commonly understood.

Geological age is partly determined by fossil evidence. Now, the presence of living beings (subsequently fossil) depends on mineral and other conditions, such as temperature, depth, currents, &c., which were nowhere the same for large spaces, but were always undergoing changes from plutonic and other causes—changes always more or less local and limited, the deposits being thick or thin in places: so that the universal scheme of palæozoic life was not everywhere worked up to the same point; here preparations were making for Lower Silurian deposits,—there for the Upper, or Devonian, and so on. Thus isochronism was perhaps not common.

27. The principles of recurrency, succession, increment, and relative abundance of fossil species are the same in New York, Wales, and elsewhere, modified by local circumstances.

28. Recurrency, or reappearance in different strata, is at the same time the measure of viability in the species, and of connexion in the groups of strata. It is a kind of living nexus, pointing out that the groups belong to one and the same order of things. It may have been partly caused by migration.

Recurrency is not so common in New York as in Wales,—in other words, vertical range is longer in Wales. Great depth is an obstacle to the existence or transmission of living creatures.

29. Everywhere, on the eastern as well as on the western continent, the same fossils, of all orders and kinds, appear in the same succession. A very few Crustacea and a *Lingula* or *Obolus* or two, amid a dense matting of fucoids, appear at what now seems to be the dawn of life; then some Gasteropoda, a few Cephalopoda, and a few Brachiopoda in the third group from below (Chazy). But in the fifth group from below (Trenton,) multitudes of Zoophyta, Bryozoa, Brachiopoda (save *Spiriferi*,) Orthocerata, and Trilobites spring forth; but not a Lamellibranchiate. As species, they nearly all perish with the advent of a new deposit; but,

as genera, they appear one after another through the successive epochal centres, becoming multiplied in numbers and perfect in form. Then they lessen in numbers, dwindle in size, and finally disappear.

30. There is a close similarity in New York and Wales in the increment and decrement of Zoophyta, Bryozoa, Echinodermata, Brachiopoda, &c.; that is, these fossils are numerous and few at the same points of the Silurian scale.

31. The same genera, species, and amount of individuals abound or are few in the countries just named. Brachiopoda, Crustacea, Orthocerata, are many; Lamellibranchiates few. The extraordinary opulence in fossils of the Rhenish Devonian strata does not obtain in New York. In New York, however, according to our present list, the Lower Silurian stage is the most fossiliferous; in Wales, it is the Upper. Future discoveries may change this condition of things.

32. A remarkable feature in the uppermost four groups of New York Siluria (the Lower Helderberg) is the substitution in them of limestone for the arenaceous mud of the Welsh Ludlows, their contemporaries. It has given them a Wenlock character. But it is to be remembered that the Ludlow and Wenlock groups of Wales are in close fossil connexion, —74 out of 311 species of organic remains being common to both, or very nearly one quarter.

I shall not proceed at present with these inferences into the American Devonian system, although there is no want of interest. I may just remark that many Silurian Brachiopoda and some other molluscs work themselves up into the Devonian as representatives of a common period. They may even be found in the Carboniferous system, as has been proved by D'Archiac and De Verneuil to be not uncommonly the case in Europe.

The great ruling zoological principles of the Silurian system are continued into the Devonian; but in the latter we have the introduction of Vertebrates in profuse variety, and of new and complex types of Invertebrates in unwonted abundance, the old forms dying out.

6. *Report of the State House Artesian Well at Columbus, Ohio;* by W. W. Mather. 42 pp., 8vo., Columbus, 1859.—The Artesian well at Columbus had reached a depth of 1858 feet early in last December. For the first 23 feet the material passed through was sand, clay and gravel; then 15 of slate and 14 feet of Columbus limestone referred to the Devonian; 115½ feet Columbus limestone, probably Upper Silurian; below this 277 feet, the blue limestone of Cincinnati; then 187 feet (or to a depth of 764 feet,) limestone shales with salt water at 675 feet; then 823 feet of greenish marley slates, probably equivalent to the Utica slates of New York. Prof. Mather observes that "if the Cincinnati or Blue limestone be the equivalent of the Trenton limestone, Utica slates and Hudson river group, there must be a great depth of mud rock in Ohio, of which no traces exist in New York, Pennsylvania, or other States around us," and he inclines to regard the Blue limestone as Upper Silurian, but without settling the question by a sufficient appeal to facts.

7. *Synopsis des Echinides Fossiles;* par E. Desor. 1 vol. text, and 490 pp. 8vo, with 1 vol. of 44 8vo plates. Paris and Wiesbaden, 1858. —This work by Mr. Desor, now of Neufchatel, is devoted to the fossil Echinidæ, and contains descriptions of 1415 species of all geological ages, with a very large number of fine figures on the 44 crowded plates.

III. BOTANY AND ZOOLOGY.

1. *British National Museums of Natural History.*—The separation of the Natural History collections at the British Museum from the library and antiquities, seems to be inevitable at no distant period. An influential memorial, addressed by leading naturalists to the Chancellor of the Exchequer, strongly recommends this separation to be effected at the present time; and it is thought that the recommendation will be adopted. It is proposed to establish separate museums of zoology, botany, and mineralogy, and even to divide each of these into a *typical* or *popular*, an *economic*, and a *scientific* department, the two former open always to the public, the latter to men of science. The zoological and perhaps the mineralogical collections it is proposed to concentrate in some part of London or the immediate vicinity, probably at Kensington Gore; the botanical collection would of course go to Kew, where the national botanical garden,—brought to a high state of perfection under Sir Wm. Hooker's superintendence,—and a large museum of economic botany, most successfully established by him, already exist. There is likewise an excellent herbarium, which was some years ago presented to the establishment by Mr. Bentham. There also is the great herbarium of Sir Wm. Hooker, perhaps the largest in the world,—certainly far larger than any other ever formed in one life time, or by a private person, and the one which for the last twenty years has contributed more than any other to the advancement of the science. For almost 20 years the Hookerian herbarium —even more than the Royal Gardens—has made Kew the head-quarters of botany, rivalling the imperial establishment on the other side of the channel, and more useful as well as more freely accessible to botanists from every part of the world than the national herbaria at the British Museum. As to accessibility, indeed, no fault is to be found with the latter; the Banksian and other herbaria of historical importance could always be consulted under proper regulations. But it must be said that, with the greatest botanist of the age as their curator, these national collections for a quarter of a century have not contributed to the advancement of botany to any thing like the extent which the Hookerian herbarium, and its devoted, generous-spirited, and disinterested founder have done. How such a vast herbarium can have been collected and maintained, in perfect working order, by a private individual of very moderate means, it is not easy to conceive. Certainly it is too large and too important for science long to remain in private hands. It must in any case be acquired by the British Government; when this and the Benthamian herbarium, with adequate provision for their increase,—supplemented by the Banksian and other special collections now at the British museum (which should be kept distinct)—will form an unrivalled *scientific botanical museum*. A. G.

2. *On the Coiling of Tendrils;* by Prof. GRAY.—As much as twenty years ago, Mohl suggested that the coiling of tendrils 'resulted from an *irritability* excited by contact.' In 1850 he remarked that this view has had no particular approval to boast of, yet that nothing better has been put in its place. And in another paragraph of his admirable little treatise on the Vegetable Cell (contributed to Wagner's *Cyclopædia of Physiology*), he briefly says: 'In my opinion, a dull irritability exists in the

stems of twining plants and in tendrils.' In other words, he suggests that the phenomenon is of the same nature, and owns the same cause (whatever that may be) as the closing of the leaves of the Sensitive-plant at the touch, and a variety of similar movements observed in plants. The object of this note is to remark that the correctness of this view may be readily demonstrated.

For the tendrils in several common plants will coil up more or less promptly after being touched, or brought with a slight force into contact with a foreign body, and in some plants the movement of coiling is rapid enough to be directly seen by the eye; indeed, is considerably quicker than is needful for being visible. And, to complete the parallel, as the leaves of the Sensitive-plant, and the like, after closing by irritation, resume after a while their ordinary expanded position, so the tendrils, in two species of the *Cucurbitaceæ*, or Squash family, experimented upon, after coiling in consequence of a touch, will uncoil into a straight position in the course of an hour; then they will coil up at a second touch, often more quickly than before; and this may be repeated three or four times in the course of six or seven hours.

My cursory observations have been principally made upon the Bur-Cucumber (*Sicyos angulatus*). To see the movement well, full-grown and outstretched tendrils, which have not reached any support, should be selected, and a warm day; 77° Fahr. is high enough.

A tendril which was straight, except a slight hook at the tip, on being gently touched once or twice with a piece of wood on the upper side, coiled at the end into 2½–3 turns within a minute and a half. The motion began after an interval of several seconds, and fully half of the coiling was quick enough to be very distinctly seen. After a little more than an hour had elapsed, it was found to be straight again. The contact was repeated, timing the result by the second-hand of a watch. The coiling began within four seconds, and made one circle and a quarter in about four seconds. It had straightened again in an hour and five minutes (perhaps sooner, but it was then observed); and it coiled the third time on being touched rather firmly, but not so quickly as before, viz. 1½ turns in half a minute. I have indications of the same movement in the tendrils of the grape-vine; but a favorable day has not occurred for the experiment since my attention was accidentally directed to the subject. I have reason to think that the movement is caused by a contraction of the cells on the concave side of the coil, but I have not had an opportunity for making a decisive experiment.—*Extr. from Proceedings of the American Academy of Arts and Sciences*, vol. iv, p. 98, *Aug.* 1858.

3. *An Essay on the Tape Worms of Man*, giving a full account of their Nature, Organization, and embryonic development, the pathological symptoms they produce, and the remedies which have proved successful in modern practice, by D. F. Weinland, Ph.D.,—to which is added an Appendix containing a catalogue of all species of Helminths hitherto found in man. 94 pp., 8vo, illustrated with original wood cuts. Cambridge, Mass., 1858. Metcalf & Co.—Dr. Weinland is high authority on all subjects connected with Intestinal worms, and especially the species that infest man, of which 32 are now known. This pamphlet is valuable both pathologically and zoologically. Nothing in the whole range of

animal life is more strange than the history of the tapeworm, and as the facts have not been in this Journal, we cite a few paragraphs on the subject.

"Every butcher is acquainted with the disease in the muscles of the domesticated hog, denominated 'measles,' and calls the flesh of such a hog 'measly pork.' It has long been known that those pea-like whitish globules (measles) contain a curious animal, namely, the perfect head and neck of a tapeworm, ending however, not in the long, jointed body of the regular tapeworm, but in a water-bladder. No traces of reproductive organs are to be seen. Such measles are found not only in the hog, but also in other animals, where they are better known under the name of *Hydatids.* For example, they are very often met with in the liver of rats and mice; in the mesentery of the hare; and even, though more rarely, in the muscles of man; and those of the latter have turned out to be of the same species (*Cysticercus Cellulosæ,* Rudolphi) as those found in the hog. All the different species of this sort of hydatids are known in science under the generic name of *Cysticercus.*

Again, other hydatids, varying from the size of a pea to a diameter of several inches, are occasionally found in the lungs, the liver, and other organs of man, but more frequently in the liver and lungs of our domesticated Ruminants, such as oxen, sheep, and goats. These hydatids are roundish bladders of a milky-white color, containing a watery fluid, in which swim many whitish granules; each of these granules is, as a good lens will show, a well-developed head and neck of a Tænia, inverted into a little bag. This kind of hydatid, also, has been considered as a distinct genus of intestinal worms, and called *Echinococcus.*

Again, a disease frequently occurs in the brain of sheep, producing vertigo (German, *Dreher,* French, *tournis*). This was ascertained, years ago, to be caused by another sort of hydatid, appearing as a bladder, often of several inches in diameter; and, as in Cysticercus and Echinococcus, filled with a watery fluid. On the outside of these bladders are attached a number (often hundreds) of tapeworm heads, all retractile into the inside of the bladder by inversion like the finger of a glove. This hydatid was considered by zoologists as a third genus, called *Cœnurus.*

These three genera, *Cysticercus, Echinococcus,* and *Cœnurus,* formed until recently an order in the class of intestinal worms, called *Cystica* (Bladder worms, or Vesicular Worms). But *we now know that all of this group are merely larves of tapeworms,* and that the whole order of *Cystica,* being composed of larves of *Cestoidea,* must therefore be dropped from our zoological system.

This important discovery was made as follows. Ephraim Götze, a German clergyman and naturalist of the last century, had noticed a singular similarity between the heads of some Cysticerci and those of some tapeworms. He had particularly noticed this similarity between the tapeworm of the cat (*Tænia crassicollis,*) and the Cysticercus which is found in the liver of the rat and mouse (*Cysticercus fasciolaris*). C. T. von Siebold, the most noted helminthologist now living, had observed the same thing, and in 1848 had already alluded to the possibility that all these Cystica might be nothing but undeveloped or larval tapeworms. In his system, however, he still recognized the *Cystica* as a distinct order of Helminths.

In the year 1851, F. Küchenmeister first proved by experiment that a certain hydatid when brought into a suitable place, is developed into a tapeworm. He fed a dog with the hydatids (*Cysticercus pisiformis*) found in the mesentery of the hare, and on dissecting the dog, after a number of weeks, *found these Cysticerci alive in the small intestine. They had, however, lost their tail-bladder, and the neck had begun to form the joints of a true tapeworm,* which worm had been long well known as *Tænia serrata,* and as common in the dog. Now, one discovery followed another. Governments, scientific institutions, and wealthy farmers furnished the money and animals to carry on the experiments on a large scale. Siebold fed a dog with the *Echinococcus* of the ox, and thus raised the *Tænia Echinococcus,* Siebold. It was also found in the same way that the *Cœnurus* from the brain of sheep is the larve of another *Tænia* of the dog, *Tænia Cœnurus,* Siebold.

Now the question, whence does man get his tapeworm? was ready to be answered. It had been observed that the hydatids of the hog, commonly called "measles" (in the zoological system, *Cysticercus Cellulosæ,*) have exactly the same head as the common tapeworm of man (*Tænia Solium,* L.); and after the experiments mentioned above, in relation to the different tapeworms of dogs, a doubt could hardly exist *that Cysticercus Cellulosæ of the hog was the larve of the common human tapeworm* (*Tænia Solium*). Küchenmeister, who wished to make sure of the fact, made the experiment upon a criminal who was soon to be executed, and, as was to be expected, with perfect success. Measles taken from fresh pork, and put into sausages which the criminal ate raw, at certain intervals before his death, were found again, in the post-mortem examination, as tapeworms in his intestine, and in different stages of development, according to the intervals in which the measles had been taken.

Thus it became clear, that all hydatids are tapeworm larves, which, when swallowed with the animal, or a portion of it, in which they live, by another animal, develop in the intestine of the latter. * * * *

Now the opportunity for experiments was again open in another direction. If the tapeworm embryo developed its scolex or head by interior budding, it was likely that those animals having hydatids got them by eating the eggs of the species of tapeworm to which those hydatids belonged. And this has been proved by experiment. Goats fed with eggs of the *Tænia Echinococcus* got the Echinococcus; sheep fed with the eggs of *Tænia Cœnurus,* got the Cœnurus in their brain; *healthy young hogs fed with the eggs of the human tapeworm got the measles.* Küchenmeister, Siebold, Van Beneden, Gurlt, Luschka, Wagener, Leuckart, Eschricht, and others, have the merit of tracing this interesting development. From their further investigation, it became moreover evident, that the Cœnurus also, with its many heads, originated from *one* embryo, which, enlarging greatly, throws out as buds from its interior, not one, but many scolices; moreover, that the process is also exactly the same in *Echinococcus,* except that in this hydatid the scolices free themselves after a while from the internal walls of the bladder, and thus swim in the fluid contained in the bladder, the latter itself being simply the enlarged embryo.

But the zeal of these investigators did not rest here. If the sheep gets by chance the eggs of the *Tænia Cœnurus* of the dog into its stom-

ach, how do the embryos hatching from those eggs reach a suitable place for their development into hydatids, which place is, in the sheep, the brain? It had been erroneously assumed that they bored with their spines *recta via* from the stomach through all the tissues and organs until they reached the brain. Accordingly, in the hog, the embryos of the Tænia would have to go from the stomach into the muscles; in the rat, into the liver; and in the ox, into the lungs; for it is only in these particular organs that these hydatids are found.

R. Leuckart, however, discovered the way in which the embryos actually reach their destined resting places. On feeding rabbits with the eggs of *Tænia serrata*, he found that, some hours after the feeding, the egg-shells were already dissolved into prismatic granules by the juices of the *stomach*, and the embryos set free. But on putting the eggs immediately in the *intestine* (through an artifical opening,) they were not hatched. It was clear, therefore, that only the gastric juice could hatch the embryos; and this accounts at once for the strange fact, that the embryo never hatches in the intestine of the animal where the tapeworm itself lives. Moreover, he found that they do not pass from the stomach into the intestine, and hence, as had been supposed, through the bile-ducts into the liver, but that they pierce the blood-vessels, and *thus come into the circulation*. He even, after a long search, found four perfect embryos in the blood taken from the *vena portæ*. *It is by the blood that the embryos of tapeworms are carried to the organs in which they develop iuto hydatids*. It now at once became obvious how easily they reach the muscles, the brain, the lungs, etc. But it is to be supposed that only those which reach the destined organ will develop themseves, while the rest, which are carried to other organs, must perish."

The subject is continued with a full description of the common tapeworm and of other species. The extreme length is stated by Diesing at twenty-four feet.

4. *Depth of Molluscs of Peconic and Gardiner's Bays, Long Island, N. Y.;* by Sanderson Smith. (Communicated for this Journal.)

Name.	Depth.	Remarks.
Loligo illecebrosa,		Large and abundant.
Ranella caudata,	— to 10 f.	Moderately abundant.
Pyrula canaliculata,		Abundant.
Pyrula carica,	L. W. to 10 f.	"
*Buccinum plicosum,	H. W. to 10 f.	Large and abundant.
*Nassa obsoleta,	Littoral.	Very abundant.
*Nassa trivittata,	2 f. to 10 f.	Abundant.
*Columbella avara,	L. W. to 10 f.	Moderately abundant.
*Columbella Gouldiana,		Rare.
Columbella lunata,	L. W. to 10 f.	Mod. abundant.
Pleurotoma cerinum,*		Rare.
Pleurotoma plicatum,	2 f.	Not so rare as preceding.
*Natica heros,	10 f.	Rare and small.
*Natica duplicata,	10 f.	" " "
*Natica triseriata,	2 f. to 10 f.	Mod. abundant.
Natica pusilla,*		One dead specimen.

Names.	Depth.	Remarks.
*Natica immaculata,		One dead specimen.
Eulima subangulata,*		Rare.
Chemnitzia producta,*		"
*Chemnitzia fusca,		"
*Chemnitzia seminuda,	2 f.	Only once found, numerous.
Chemnitzia trifida,	Low water.	Moderately abundant.
Chemnitzia bisuturalis,	Low water.	Rare.
*Chemnitzia interrupta,	4 or 5 f.	"
Scalaria clathrus,*		One dead specimen.
Scalaria lineata,*		" " "
Cerithium Sayi,	L. W. to 2 f.	Extremely abundant.
Cerithium nigrocinctum,*	L. W. to 10 f.	Rare.
Cerithium Greenii,	L. W. to 2 f.	"
Cerithiopsis Emersonii,*	4 f. to 10 f.	Moderately abundant.
Cerithiopsis terebellum,*	4 f. to 10 f.	" "
Cæcum pulchellum ? *	In sand at 10 f.	Abundant.
Vermetus radicula,*		The tip of one specimen.
*Littorina rudis,	Littoral.	Very abundant.
*Littorina littoralis (animal white),	Littoral.	Abundant.
Littorina " (animal black),	Littoral.	"
*Lacuna vincta,	Low water.	Moderately abundant.
" " var. fusca,	" "	" "
*Rissoa minuta,	Low water.	Extremely abundant.
Skenea ? n. s.*		One dead specimen.
*Calyptrea striata,		" " "
*Crepidula fornicata,	H. W. to 10 f.	Very abundant.
*Crepidula convexa,	L. W. to 10 f.	Abundant.
*Crepidula unguiformis,	L. W. to 10 f.	"
*Tectura testudinalis,	Low water.	Moderately abundant.
Chiton apiculatus,	4 f. to 10 f.	" "
*Melampus corneus,	Littoral.	Very abundant.
Actæon punctostriatus,		Rare.
*Bulla solitaria,		"
*Bulla canaliculata,	2 f.	Not so rare as preceding.
Æolis, n. s. ?	Low water.	One specimen.
Ostrea borealis,		Rare.
*Anomia ephippium,	H. W. to 10 f.	Very abundant and large.
" vars. electrica and squamula.		
Anomia aculeata,		Rare.
*Pecten irradians,	L. W. to 3 or 4 f.	Extremely abundant.
*Mytilus edulis,	Littoral.	Not very abundant.
*Mytilus modiolus,	— to 10 f.	Abundant.
*Mytilus plicatulus,	Littoral.	"
Arca transversa,	3 f. to 10 f.	"
Arca pexata,		Rare.
Nucula proxima,	2 f. to 10 f.	Abundant.
Leda limatula,	2 f. to 3 f.	Rare.
Leda sapotilla,	3 f.	"
*Solemya velum,	4 f. to 10 f.	"

Names.	Depth.	Remarks.
Solemya borealis,		A fragment.
Cardium Mortoni,	L. w. to 1 f.	Abundant and large.
*Cardium pinnulatum !		One valve.
Astarte mactracea,*		Dead specimens abundant.
*Venus mercenaria,		Moderately abundant.
*Cytherea convexa,		One valve.
*Venus gemma,	— to 2 f.	Very abundant.
Petricola dactylus,		Rare.
*Petricola pholadiformis,		"
*Mactra lateralis,	2 f. to 6 f.	"
*Mactra solidissima,	10 f.	Rare and small.
*Kellia planulata,		"
Montacuta elevata,		One valve.
*Tellina agilis (St.),	2 f. to 6 f.	Moderately abundant.
Tellina tenta,*	— to 6 f.	" "
*Tellina fusca,	— to 6 f.	" "
Cumingia tellinoides,*		" "
*Solen ensis,		Not very abundant.
Solecurtus bidens,*		Rare.
*Mya arenaria,	Littoral.	Very abundant.
Corbula contracta,		Abundant.
*Anatina papyracea,	3 f.	Two specimens.
*Cochlodesma leanum,	3 f.	Rare.
*Lyonsia hyalina,	— to 6 f.	Moderately abundant.
Thracia Conradi,		A few odd valves.
*Pandora trilineata,	3 f. to 6 f.	Rare.
*Saxicava distorta,		"

Turdo, Theca, Ascidia, a Cynthia, a Molgula, two or three Aplysiæ, and six or seven Botrylli and Polyclina.

Recapitulation.—One Cephalopod, forty-three Prosibranchs, one Pulmonifer, three Tectibranchs, one Nudibranch, forty-one Lamellibranchs, and fifteen Tunicates, altogether one hundred and five marine species. Besides these, *Astarte castanea, *Cyprina islandica,* *Mesodesma arctatum, *Purpura lapillus, and *Buccinum undatum, occur on the Sound and about Montauk Point, making a total of one hundred and ten species for the eastern end of Long Island. Twenty-nine of these (marked with a * after them) excluding the Tunicata, are additional to those stated by Dekay to occur in the waters of the State, though many of them are surmised by him to exist there. I have no access to a library, to determine how many have since been described as coming from them. Including the Tunicata, the number would rise to forty-three or forty-four. Sixty-two species (marked with a * before them), or sixty-five per cent, (excluding the Tunicata,) pass Cape Cod. Only twenty-nine other species are stated by Mr. Stimpson, in his "Shells of New England," to pass the Cape, so that 68·1 per cent of the whole number occur here; and a little dredging about Montauk would probably discover nearly all the others.

IV. ASTRONOMY.

1. *Fifty-fourth and fifty-fifth Asteroids.*—The asteroid discovered Sept. 10, 1858, by M. Goldschmidt at Paris, has been named *Alexandra*, and is numbered as the *fifty-fourth* of the series. The asteroid discovered on the same night, by Mr. George Searle at Albany, N. Y., has been named *Pandora*, and is numbered the *fifty-fifth.*

2. *Another Asteroid.*—In 1857, Mr. E. Schubert of Washington, undertook a series of observations of the asteroid *Daphne.* On computing his observations he was surprised to discover that he had not found Daphne but had observed for it a new asteroid in the neighborhood. He has computed its elements, and it is to be hoped that the body will be redetected.

3. *Review of Gilliss's Astronomical Observations in Chili,** (from Gould's Astronomical Journal, 1858, p. 168).—This volume, though bearing the date of the year in which the observations were printed, has only been issued a few weeks. It contains 332 pages of observations of *Mars* and *Venus* during two oppositions of the former and inferior conjunctions of the latter, made at Santiago by Lieut. Gilliss or under his superintendence. These series comprise both micrometric comparisons with the equatorial, and absolute determinations with the meridian circle. These are followed by 69 pages from the Washington Observatory, containing a description of the equatorial and a series of micrometric observations by Mr. Ferguson of each of the four oppositions or conjunctions. A portion contributed by Mr. Bond of the Cambridge Observatory contains 43 pages of observations of *Mars* during the opposition of 1849–50, chiefly micrometric determinations of right-ascension. Finally, Mr. Maclear, of the Royal Observatory at the Cape of Good Hope, has furnished an extensive series of micrometer-comparisons with the preselected stars, during the first opposition of *Mars.*

These 492 pages of observations and accompanying remarks are preceded by introductory remarks upon the origin and operations of the expedition, with a description of the instruments and method of observation employed, by Lieut. Gilliss; and by a detailed discussion of the entire mass of observations by the editor of this Journal. This discussion occupies 264 pages.

The plan of the expedition contemplated micrometric comparisons of the limbs of the planets, with stars previously selected by Lieut. Gilliss for the purpose, simultaneously made in the northern and southern hemispheres; but the extremely small number of northern observations precluded all hope of attaining any valuable addition to our knowledge of the Solar Parallax by this method.

In the earnest desire that so extended and costly a series of careful observations should not prove futile for the attainment of the desired end, a method of discussion has been employed, which, though entailing an inordinate amount of toil, seemed to afford the only adequate means of rendering the observations serviceable for the fulfilment of their design. The method may be briefly described.

* The U. S. Astronomical Expedition to the Southern Hemisphere, during the years 1849–52. Vol. III: Observations to determine the Solar Parallax, by Lieut. J. M. Gilliss, LL.D., Superintendent. Washington, 1856. 4to.

A catalogue of the comparison-stars having been prepared, their declinations were obtained from a thorough examination of all the available sources, and from the combination by weights of the positions as given by the several authorities. Regard being had to the existence of any possible proper motion, the positions obtained were referred to the mean equinox of the beginning of the year in which the comparisons were made, and a final list of comparison-stars thus constructed, containing not only the declinations of each star, but the relative value of the determination.

The complete reduction of all the observations was then repeated, and the several comparisons with each star consolidated with care into a single observation, of which the weight was determined, and which was subsequently treated like an absolute determination of place, and even combined with meridian observations. Each of the four series (viz. the two *Mars*-oppositions and the *Venus*-conjunctions) was treated independently, and the error of the ephemeris considered as of the form $x + \tau y + \tau^2 z$, τ denoting the time from a medial epoch. Four other unknown quantities were introduced,—two of these relating to the apparent semidiameter, one depending on the micrometer employed, and the last being the correction to Encke's determination of the mean solar parallax. The observations at each place have been independently discussed, and the several groups finally combined in series of approximate solutions by least squares.

The sequel indicates that the results afforded by the series of observations of *Mars*, during the opposition of 1849–50, so far surpass any of the others in precision and trustworthiness, that these, taken alone, promise a closer approach to the desired values than when combined with the three other series.

The resultant determinations of the whole discussion are as follows:

Semidiameter of *Mars*	$= 4''\!\cdot6639 + 1''\!\cdot9681 = 6''\!\cdot63$
" " *Venus*	$= 8\cdot6625 - 0\cdot3118 = 8\cdot35$
Mean Solar Parallax	$= 8\cdot5712 - 0\cdot0762 = 8\cdot4950$

The great increase of the previously assumed semidiameter of *Mars* is very striking. It has proved impracticable in most cases to free the semidiameter from the possible influence of an irradiation dependent on the observer or on the telescope. The adopted value depends on the Washington and Santiago observations only. The necessity of some increase to the previously adopted value is indicated by six series of observations; being all made, during the first opposition, with the exception of the Cape of Good Hope series.

The propriety of a small diminution of the adopted diameter of *Venus* seems also to be distinctly and strongly pointed out.

Upon the resultant value of the parallax I am not inclined to place any great stress, but cannot refrain from expressing the decided conviction that the value obtained by Encke from the transits of *Venus* in 1761 and 1769 may be improved by a slight decrease; and am inclined to regard the value $8''\!\cdot5000$ as being in all probability quite near the truth, and that this value may be advantageously adopted. G.

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Mountains of North Carolina and Tennessee;* by S. B. Buckley. (Communicated for this Journal).—During the summer of 1835, Professor Elisha Mitchell of Chapel Hill University, North Carolina, measured the highest point of the Black Mountain in that State, and announced its height to be 6476 feet. His stationary barometer was at Morganton, which he *estimated* to be 968 feet above the sea. The late railroad surveys show that the Morganton depot is 1169 feet high; making the place where Dr. Mitchell's stationary barometer hung, 1200 feet above the level of the sea. Hence the height of Mount Mitchell—the name which has justly been given to the highest part of the Black Mountain—according to the indications given by Prof. Mitchell's barometer in 1835, is 6708 feet. This measurement of 1835 was first published in the Raleigh Register, and again in Silliman's Journal in 1839, with some additional remarks by Dr. M., in which he alludes to the great apparent height of the mountains in Haywood county, and also to the highest in the Great Smoky Range. The Highland Messenger, published at Asheville, near the Black Mountain, in 1840 when alluding to Dr. M.'s measurement of it, says: "we are perfectly willing to concede the name of Mount Mitchell to that particular point of the Black Mountain which Prof. Mitchell, after a degree of labor and expense, which none other than a genuine devotee of science would have incurred, demonstrated to be the most elevated point of *measured* land east of the Rocky Mountains. We say measured land, because we have long believed, and still believe that there is one, if not two points, in the same range of mountains higher than that measured by Prof. Mitchell, from forty to sixty miles west of the Black Mountains." This is from an editorial by the Rev. D. R. McKally, D.D., now editor of the Christian Advocate at St. Louis, Missouri. We have quoted it, because his *higher points* are probably the two highest which we have recently measured in the Smoky Range, about sixty miles nearly west of the Black Mountains.

In the Transactions of the Smithsonian Institution for 1855, is Mr. Clingman's account of the Black Mountain, the highest point of which he estimates to be 6941 feet, which is 233 feet higher than Prof. Mitchell's corrected height of the same point. Prof. Turner the engineer has since found its height to be 6711 feet, and in 1856 Prof. Guyot by a series of barometrical observations, ascertained it to be 6701 feet high. There is little discrepancy between the measurements of Professors Mitchell, Turner and Guyot, and hence there can be little doubt that Mr. Clingman's estimated height of the Black Mountain, as first given in the Smithsonian Transactions, and now in Colton's new atlas of the World, and also in Lippincott's Gazetteer, is at least 230 feet above its true height.

Prof. Mitchell in 1838 and 1844 again visited the Carolina mountains, at which time his stationary barometer was at Asheville. The following measurements, then made, are taken from a letter of his, published in an Asheville newspaper.

	Above the sea.	
"Asheville,	2200	feet.
French Broad river at Asheville,	1977	"
Lower Ford of Pigeon,	2475	"
Waynesville,	2722	"
Head of Scott's Creek,	3240	"
Tuckaseige Ford,	1927	"
Gully Whee Gap,	3897	"
Blue Ridge head of Tuckaseige,	3795	"
Col. Zachary's Cashiers valley,	3824	"
Chimney Top,	4433	feet.
" " above Zachary's,	1109	"
Burnsville,	2763	"
Top of Black Mountain,	6772	"
Morganton,	1081	"
Table Rock,	3584	"
Grandfather,	5719	"
Roane,	6187	""

It should be remembered that these measurements were also made previous to the railroad surveys, by which it is now known that the height of Asheville near the court house is 2260 feet.

For the convenience of future observers we give below, Prof. Guyot's measurements in 1856, in and around the Black Mountains, the three last excepted.

	Above the sea.	
Jesse Steppa, Lower Mountain house, Swaninoa valley,	2770	feet.
Terminus of carriage road up Black Mt. to Wm. Patton's Mt. House,	3244	"
Potatoe Top,	6389	"
Mitchell's Peak,	6577	"
Mount Gibbes,	6586	"
" Haulback,	6401	"
Sandoz Peak,	6612	"
Cattail Peak,	6595	"
Rocky Trail Peak,	6486	"
Deer Mountain,	6216	"
Long Ridge Middle Peak,	6253	"
Bowlen's Pyramid at north end of the Black,	6345	feet.
Wm. Patten's Mt. House,	5248	"
Mt. Mitchell, "highest,"	6701	"
Guyot's Peak,	6661	"
Hairy Bear,	6597	"
Junction of Cattail Fork and Caney river,	2824	"
Burnsville court house square, near Penland's Hotel,	2819	"
Mount Pisgah,	5760	"
Roane Mt.,	6318	"
Grandfather, measured in 1858,	5897	"

Prof. Guyot remarks in a letter to us containing his measurements in 1856, that "these heights may be modified by a few feet in" his "final publication, the point of base not being identified within three feet."

The following are the heights of some mountains and places in North Carolina and Tennessee, south and west of Asheville, which were measured by us with two of Green's standard barometers during the months of September and October in 1858. Prof. J. LeConte of Columbia, S. C., observed the stationary barometer at Waynesville, N. C., for the measurement of most of the highest Smoky Mountains, but being called away by the duties of his professorship, the stationary barometer was removed to Col. Cathey's, at the Forks of Pigeon, Haywood Co., N. C., and placed in charge of Miss S. Cathey. We also received material assistance from Mr. T. J. Lenoir and Mr. Turner Cathey, during our mountain excursions.

	Above the sea.	
Waynesville,	2815	feet.
Col. Cathey's,	2750	"
Platt's Peak,	6196	"
Jones' "	6337	"
Amos Platt's Balsam,	6406	"
Cold Mountain,	6105	"
Shining Rock,	6063	"
Father Old-Field,	6116	"
Hyman's Peak,	6095	"
Cathey's "	6240	"
Wilson's Balsam,	6270	"
Mount Hargrove,	6156	"
Devil's Court House,	6057	"
Lenoir's Bald Mt.,	6040	feet.
Mount Hardy,	6257	"
Mount Lenoir,	6413	"
N. Peak of Mt. Lenoir,	6399	"
Sarah's Mountain,	5993	"
Mount Cathey,	5742	"
" Starling,	6456	"
" Emmons,	6465	"
Flat Creek Balsam,	6087	"
Whiteside,	5076	"
Top of Whiteside to base of precipice,	1510	"
Mount McDowell,	5100	"

The following points are in the Smoky Mountains, and many of them are on the State line, between North Carolina and Tennessee.

E. P. Hopkins's house,	1995 feet.	White Rock Mountain,	5002 feet.

This last is a misnomer of the hunters, being composed of a dark gneiss and mica slate, covered in many places with white lichens, the most abundant of which are Cladonia rangiferina, and Cladonia Caroliniana.

Mount Safford,	6296 feet.	Old Field Knob,	6220 feet.
" Henry,	6425 "	Peck's Peak,	6338 "
" Guyot,	6734 "	Safford's Peak,	6559 "
" Floyd,	6078 "	Mount LeConte,	6670 "
" Mingus,	5779 "	Mount Buckley,	6755 "
Summit of Road Gap near the Alum Cave,	5314 "	Curtis' Peak,	6511 "
		Mount Collins,	6241 "
Right Hand Gap,	5162 "	Robert Collins House,	2535 "
Mount Ocona,	5978 "		

It is proper to state that most of these heights are the result of a single barometrical observation, and hence they will probably be modified somewhat by future observers. Observations were made on the two highest at two different visits, and a mean result between the two calculations is given as the height of Mount Buckley, while the height of Mount Guyot is given as ascertained by the first visit, it being made in a more settled state of the weather. The second observation at its summit gave its height as 6994 feet. It is well known to those conversant with the barometrical measurement of heights, that accuracy requires a series of observations, and it was out of our power to make them at so many points during the time to which we were limited by the lateness of the season.

Fortunately the months of September and October were uncommonly dry, which enabled us to continue exploring nearly the entire time. The toil was great, and the difficulties to be encountered can only be imagined by those who have ascended the steeps of the unfrequented Southern Alleghanies, through laurel thickets (Rhododendrons and Kalmia,) and multitudes of the prickly locust, (Robinia hispida,) which has a *penchant* for scratching the face and hands, tearing the clothes, and occasionally the skin beneath. We found the Viburnum lantanoides or hobble-bush with its straggling branches, very troublesome on the Smoky Mountains. Notwithstanding all this we have the mountains and their glorious scenery. We encamped eleven nights on their tops; and saw that the stars were brighter, and the planets apparently larger than when seen from the valleys below. Then also the wonderful comet (Donati's) made the southwest luminous with its bright head and mysterious tail, soon after the setting sun.

The scenery of these mountains, especially those in the Smoky Range, abounds in precipices and deep chasms, surpassing any thing we remember to have seen among the White Mountains of New Hampshire. The spectator on the highest Smoky Peaks can enjoy a more varied view than from any other points in the Southern Alleghanies. East Tennessee with its towns, rivers, and the Cumberland mountains in the distance, is spread beneath at the west. On the north can be seen the Clinch mountains extending into Kentucky. At the northeast, east, and southeast, in full

view are all the higher mountains of North Carolina, and at the south the smaller ones of Northern Georgia. Such prospects *pay* the explorer for his toil; their remembrance is always sweet. The country on the Tennessee side is much lower than in South Carolina, and the descent of the Smoky mountains is generally more abrupt and precipitous into the former State, than into the latter.

The highest Smoky mountains are near the head waters of the Oconaluftu and Little Pigeon rivers, being accessible from Tennessee via Sevierville, and up the Little Pigeon to a Mr. Hawkins', who lives eight miles from the top of the gap road, which is near the alum cave; and from North Carolina by the road up the Ocona-luftu to Mr. Collins's house, seven miles from the top of the afore-named gap-road.

The geology of the mountains south and west of Asheville has a good deal of sameness, they being composed of crystalline rocks, with the exception of a narrow strip, extending southwest along the Unaka or Smoky mountains which belongs to the taconic system of Emmons. The taconic rocks here consist of dark colored shales in which we do not remember to have seen any organic remains. The strata of these rocks are in many places nearly and often quite vertical. They are well exposed along the Middle or Straight Fork of the Ravensfork in descending from Mount Guyot to the Ocona-luftu. They also occur at the summit of the gap-road near Mount Mingus, and extend two or three miles down the road into North Carolina. The chief rocks of the Haywood mountains are granite, gneiss and mica slate, excepting a small portion near the Smoky Range, where the taconic rocks are again found. The Shining-Rock mountain about eleven miles south of the Forks of the Pigeon is entirely of white or milky quartz, and is probably the largest mass of that rock at any one point in the Alleghanies. It has a fine appearance in the distance and is deservedly becoming quite a place of resort. We believe that Haywood and Jackson counties, N. C., have not as yet afforded any paying mines to those who have been at the expense of working them, but it must be admitted that they have been little explored for that purpose. Prof. Emmons the State Geologist, contemplates a survey of those mountains next summer, and we suspect that he will destroy the golden dreams of a few who build castles upon undeveloped mineral wealth.

This region has long been a favorite place of resort for the botanist. Here there is a strange mixture of northern and southern species of plants, while there are quite a number which have been found in no other section of the world. In the months of May and June when the Kalmia, Rhododendrons and Azaleas are in bloom, these mountains and valleys present an array of floral beauty which is indigenous to no other section of the United States. The much vaunted western prairies with their interminable sameness, are by no means as beautiful. The Rhododendron Catawbiense, Kalmia latifolia and Azalea calendulacea, are not excelled by any native floral beauties; the two last abound in nearly every section of these mountains, but the first rarely descends into the valleys. Besides these the Rhododendron maximum, (laurel,) Rhododendron punctatum, Azalea arborescens and nudiflora, Oxydendrum arboreum, Chionanthus Virginica, Halesia tetraptera, Clethra acuminata, Robinia hispida and

viscosa, Stuartia pentagyna, Liriodendron tulipifera, Magnolia acuminata, Umbrella, and Fraseri, grow there more or less abundantly, and they are all ranked as among the most ornamental trees and shrubs of the Atlantic States. The Pyrus Coronasia is very common south of the French Broad river; Catalpa occurs in several places along the same river and in the mountain valleys near the Warm Springs; Cladastris, grows at Paint Rock, Tenn., which is near the Warm Springs. Most of the highest mountain tops are covered with the Abies nigra and Abies Fraseri: the former is the black spruce, and is erroneously called the balsam; the latter is the true balsam with blisters in its bark, from which balsam is collected. It attains a greater size than Pursh or Nuttall have given it in their works. We measured some on Wilson's Balsam and near Cathey's Peak, which were more than three feet in diameter and from eighty to one hundred feet high. The black spruce appears to grow at a lower elevation than the balsam, but neither of them are often met beneath an height of 4000 feet.

The banks of streams and coves of these mountains have some of the largest trees in the United States east of Mississippi river. There is a Tulip tree or Poplar (Liriodendron tulipifera,) near the Pigeon river in Haywood Co., N. C., about eight miles from the Tennessee line, thirty-three (33) feet in circumference at three feet from the ground, or eleven feet in diameter, and upwards of one hundred feet high. Another on the western slope of the Smoky mountains in Tennessee, on the Little Pigeon river, is twenty-nine feet in circumference at three feet from the ground. Near this locality we also measured a chestnut (Castanea vesca,) thirty-three feet in circumference at four feet from the ground. It is a noble living specimen, apparently sound, and of nearly a uniform diameter upwards, for forty or fifty feet. About two miles farther up the same stream there is a hemlock, or spruce pine, (Abies Canadensis) nineteen feet and two inches in circumference at four feet from its base. Here also the Halesia tetraptera attains an uncommon size, being from two to three feet in diameter, and about sixty feet high. On Jonathan's Creek there is a white oak (Quercus alba,) nineteen feet in circumference at three feet from the ground. This list of large trees could greatly be extended, but enough have already been cited to show the richness of those coves and valleys.

The Quercus Leana of Nuttall occurs at several places on the Tennessee river near Franklin in Macon Co., North Carolina. It is evidently there a hybrid between Quercus imbricaria and Q. tinctoria. Its acorns are identical with those of the Q. imbricaria. On the Haywood mountains we saw a few specimens of the Betula excelsa (yellow birch), and Mr. Curtis says he found it on the Black mountain. Among several shrubs which we obtained for cultivation the Pyrularia oleifera or oil-nut is peculiarly interesting. It grows to the height of from five to ten feet, and bears a pear-shaped fruit little more than an inch in diameter, which is so oily that it will burn like a candle if a wick be drawn through it. Squirrels are fond of it, and cattle have a great liking for the young branches and leaves of the Pyrularia. Last spring we saw an abundance of it in the edge of some woods fenced into a wheat field, and in October we again went there after the fruit; but the harvest was past, the

field had been pastured with cattle, which had destroyed nearly all of the Pyrularia. Hence it has already become rare, and the general occupancy of the mountains with herds of cattle and flocks of sheep would soon destroy it entirely. Mr. Durand of Philadelphia thinks that the oil expressed from it is superior to the best olive oil. Our specimens of the Pyrularia have been planted at Philadelphia, New York, and at the botanic garden of Cambridge, near Boston, and also some of them have been sent to Paris to the Acclimating Society of France, whose object is to acclimate useful trees, shrubs and plants.

On Mount Mingus we first met with the Rugelia, a new genus of Shuttleworth, in the natural order Compositæ, which has not yet been described in American works on botany. It is frequently found along the Smoky mountains to the extent of twenty-five or thirty miles. Dr. Gray recognized it at once, he having received it from Mr. Shuttleworth, a European botanist to whom Rugel sent plants. Sixteen years before, in the early spring, we had visited those same mountains with Dr. Rugel, a German botanist, and we were right glad to learn that his name was affixed to one of their interesting plants. The Solidago glomerata grows on most of the Balsam mountains, and the Potentilla tridentata of the New England mountains also grows on the bald peaks of Macon county, North Carolina.

The Carolina mountains have a great variety of huckleberries (Vaccinium and Gaylussacia) ripening in succession from July to September. When we first met with acres of those bushes, in September, covered with large delicious fruit, the temptation was so great that we partook rather freely, expecting to pay the penalty of over indulgence, but were happily disappointed. Judging from the experience of others and our own on many occasions, those berries are remarkably healthy. Most of them were larger than any we ever saw at the south. The Vaccinium Constablei of Gray, which sometimes grows ten or fifteen feet high (on Shining Rock), was covered with ripe fruit as late as the middle of October. There are several species of the huckleberry which are worthy of cultivation. The common high blackberry (Rubus villosus) is often found in dense patches on and near the mountain tops, with its stems smooth, and destitute of prickles. This rule is constant. We do not remember to have met with an exception. The same species growing in the valleys has its stems armed with prickles.

In the month of September many of the women and children dig "sang," (Aralia quinquefolia,) in the valleys and on the mountain sides. The dry roots of the ginseng or "sang," as it is always there called, are worth at home twenty-five cents per pound. We met with one man who had bought 30,000 pounds, and we remember being with one family whose children sold seventy pounds of dried sang. These roots are dug with a long narrow hoe called the "sang hoe."

Snow birds (Fringilla nivalis) we saw on the Black mountain, and also on many of the other Balsam mountains south and west of Asheville. They were solitary or in pairs, showing evidently that they breed in those places. Another species of bird, whose summer habitat is generally supposed to be confined to the north, also breeds and summers in those Balsam mountains. It is the Crossbill (Loxia curvirostris) whose curious

bill is well adapted to extract seeds from the cones of the black spruce and balsam trees. In the mountain valleys we frequently met with many northern birds, among which was that sweet songster, the rose-breasted Grosbeak (Fringilla Ludoviciana).

The tedium of the night, when encamping on the mountains, is almost always enlivened by the stories of the guides and their adventures in hunting. They all positively assert that the bears in early spring, when first emerging from their winter quarters, are as fat as when they first retire for the winter. During the winter they shed the soles of their feet, which renders their walking difficult in the first of spring, when their food consists of the young plants, on which diet they soon become lean, and remain so until the ripening of berries in August and September. They are very fond of hogs and pigs, pork and honey being their favorite diet. Why they bite and scratch the bark and limbs of the balsam and black spruce we cannot tell. It cannot be for food, because they do not generally leave the marks of their teeth on a tree, except in one or two places. Sometime they rise on their hind legs and make long deep scratches in the bark with their fore paws. It may be done for sport, or to let their companions know their whereabouts. We have seen those fresh bites and scratches on different trees at all seasons of the year. The bears show great sagacity in feeding at the leeward of the paths on the mountain ridges, along which the hunter is almost obliged to travel, hence if the wind blows it is almost impossible to get a shot at them, their keen scent discovering the hunter long before he gets within shooting distance. They are stupid and unwary about traps, entering without fear the log pens; these are shallow, with a depth of not more than two feet, over which is raised a very heavy top, which falls and crushes the bear when he disturbs the bait. Hundreds are caught in this manner every year. In the unfrequented parts of the mountains the large steel trap is concealed in the bear trail; but this is dangerous, and liable to catch dogs, of which we saw two caught in one morning to our great sorrow. The piteous yells of those unfortunate dogs rang in our ears long afterwards. The bears rarely disturb calves or young cattle, but in one locality of the Smoky mountains we were told that they did much damage in killing young cattle, and that there could be no mistake about it, because a large bear had been caught in the act of killing a young steer. The panther, wild cat, and wolf are all troublesome to the mountain farmer of those regions. The panther destroys sheep and hogs; the wild cat, lambs and pigs. Both are cowardly and thievish, being rarely seen.

The Red squirrel (Sciurus Hudsonius) called Mountain Buman in North Carolina, is common on all the higher mountains. They rarely descend into the valleys. They are fond of the seeds of the balsam and black spruce, and as they are rarely molested by the hunters, they are very noisy, active, and more fearless of man than their brothers at the north. The Ground squirrels (Sciurus striatus) are also very abundant, often destroying a good deal of corn, but as corn is plenty, and larger game common, the ground squirrel is rarely killed. We were told by a travelling fur merchant, whom we there met, that the skins which he bought among the mountains, equal in fineness and goodness those of

the north, and that northern merchants could not tell the difference; still in order to get the highest price he was obliged to send his skins to New York, through Ohio and *via* the Erie Railroad as if they had come from the northwest. The principal furs obtained in the southern Alleghanies are the skins of the otter, mink, black fox, red fox, raccoon, and muskrat.

From the great height of the southern Alleghanies, there being twenty-four peaks higher than Mount Washington, it will be readily inferred that they have a northern climate. A year ago, our guide to the top of Roane told us that he had been on its summit when it was covered with snow on the 17th of June. There is a table land extending from near the Roane to the head of Turkey Cove and Linville Falls, a distance of twenty or thirty-five miles, on which the inhabitants succeed with difficulty in raising Indian corn sufficient for their own consumption. Occasionally thay have frost during every month in the year, and then they resort on horseback or on foot to the valleys for corn. About the first of last May we saw the mountains in Haywood covered with snow about six inches deep. The wheat harvest at the Forks of Pigeon begins about the first week in July; and we know of no better criterion for isothermal lines than the time of ripening wheat. We kept a record of it in western New York, and in ten years the annual time of beginning the wheat harvest did not vary three days from the 16th of July.

The valleys in the Carolina Mountains vary in elevation from two thousand to upwards of three thousand feet, hence a few miles travel will often take one to a much warmer or colder climate. This we experienced very sensibly in going from the valley of Jonathan's Creek to that of the Soco River. The former has a mean elevation of about three thousand feet and the latter near two thousand. The Chinese sugar-cane (Sorghum) is extensively grown, and may be regarded as a decided success. There are few portions of the Union where such a production is more needed. The absence of railroads and the cost of transportation render sugar and molasses dear; hence the introduction of the Chinese sugar-cane in that section is a great blessing, and will enable many a poor family to have sweet coffee.

In no section of the United States have we seen finer apples, and they are mostly from seedlings originally planted by the Indians. Silas McDowell of Franklin, in Macon Co., has devoted more than twenty years to the selection and grafting of those best native apples, and he now has an orchard of more than 600 apple trees, which bear fruit equal if not superior to the best northern kinds. There is said to be a line or belt on the mountain sides about three hundred feet above the adjoining plain or valley, and extending upwards several hundred feet, where fruit trees always bear, because the belt is free from frost. If this be true,—and we believe its truth has been pretty well tested by experiment,—the mountains of North Carolina might supply the South with an abundance of the choicest fruit, if the means of transportation were good. By the cultivation of more grass, and the introduction of the improved breeds of cattle into those mountain valleys, butter and cheese might also be made for the southern market. One great drawback to the raising of sheep is that they are destroyed by wild animals, and also killed by the

dogs. Still we think it would even pay well to keep sheep, herd them at night, and have a shepherd with his dog to guard them by day, and thus revive old Arcadian times among those delightful mountains.

2. *On some Modified Results attending the Decomposition of Bituminous Coals by Heat;* by Dr. A. A. Hayes.—When bituminous coal is exposed in proper vessels to a gradually increasing temperature, at a certain point decomposition commences and continues, while heavy hydrocarbon vapors, mixed with the vapors of water and salts of ammonia, escape, and may be condensed.

The proportion of permanent gases formed is small in comparison with the weight of the liquids produced, when the decomposition of the coal is carefully regulated.

In the ordinary rapid breaking up of the composition of coal by heat suddenly applied in the manufacture of illuminating gas, the proportion of permanent gases is increased, but the heavy fluid hydrocarbons are also formed. This mode of decomposition is evidently a mixed one, partaking of the characters of a regulated distillation, while at the same moment a more complete destruction of the coal is proceeding in some parts of the mass.

A further decomposition of the fluid products, condensed from either or both of these modes of operating, takes place when we again subject them to the influence of heat; and this well-known fact is the basis on which improvements in the manufacture of illuminating gas have been founded,—a secondary destruction of vapors being effected in appropriate apparatus, heated to a high temperature.

This character, which all the bituminous coals exhibit, of passing into carbon nearly free from vapors only when heavy fluid hydrocarbons are also formed, has, in a chemical view, been the strongest fact adduced in opposition to the generally received opinion that the anthracites and semi-anthracites have resulted from chemical changes of bituminous coal, through the agency of the heat of igneons rocks which have disturbed their beds. The heavy hydrocarbons, represented by ordinary coal tar, are the most indestructible bodies known; and wherever anthracites exist, we should expect to find near by those products of the chemical changes effected in the coal. Such is the delicacy of the balance existing between the elements of the heavy hydrocarbons, that no second distillation of them can be effected; they always undergo decomposition by heat, with the separation of carbon, which under any known natural conditions, would remain to attest their previous presence.

Considerations of this kind have led me to experiment on the changes which coals undergo by heat, where the influencing conditions were not the same as those usually seen; and the results of extended trials demonstrate that the bituminous coals may be broken up into permanent gases, vapors of water, and ammoniacal salts, while carbon remains as a fixed product.

If we substitute, for the ordinary forms of apparatus used in decomposing coal by heat suddenly applied, any modification of form which compels the gas, as it forms, to escape from the more highly heated part of the mass of coal, through a small opening, or, better, a small eduction pipe, the heavy hydrocarbons do not form part of the products which

escape. Generally the light, nearly colorless, oils of the benzole series appear with the aqueous solutions of the ammoniacal salts, while only an accidental quantity of carbon is deposited in the eduction-pipe. The carbon left is more than usually compact and hard; and such coals as ordinarily produce much water, when they form heavy hydrocarbons, afford less than half the usual amount, when thus decomposed, under the influence of the constant presence of an atmosphere of permanent gases.

In following the observations at the earlier stage, it was found that the size of the eduction-tube leading the gas from the hotter part of the mass of coal undergoing changes, exerted a most marked effect on the composition of the products. It was established as a fact, that in an ordinary coal-gas retort, the size of the conduit might be varied so as to allow the tar-like bodies to form, or to prevent their appearance at pleasure.

But a more remarkable result was obtained, when, after having prevented the production of heavy hydrocarbon fluids, the influence of reduced size of tube was studied in its relation to the composition of the gas afforded by a particular kind of coal. To a certain extent, the chemical constitution of the gas formed was found to be under control, and the conclusion reached was, that dissimilar permanent gases may be thus obtained from the same parcel of coal without a modification of temperature.

Any explanation of the change of composition induced in the volatile parts of bituminous coals under the above-described conditions should not include mechanical pressure, which is no greater than often exists in ordinary cases.

It seems probable that the presence of an atmosphere of nearly permanent gases in the decomposing vessel, and the regular continuous flow of them from the coal, prevent the formation of heavy vapors at the instant of change in the coal. In support of this point, we find the temperature necessary to convert coal into gas without the presence of heavy hydrocarbons much less high than when they are produced.

We may therefore observe the decomposition of coal without the simultaneous formation of tar, and *beds of coal may be converted under existing natural conditions to anthracite, without secondary products being formed.*

3. *Museum of Comparative Zoology in Harvard University.*—Since the connection of Professor Agassiz with the scientific department of Harvard University, he has been actively devoted, as is well known, to collecting zoological specimens and laying the foundation of a great museum. The collections already made by him or through his agency, and in great part at his own expense, are very large. The interest felt in this movement has been general through the country, and has recently taken a fresh start which is destined to lead to the most important results. The late Francis C. Gray of Boston—a gentleman extensively known for the depth and variety of his knowledge in many departments of literature, and for his liberal spirit in promoting schemes for the public good—was strongly attached to the study of the natural sciences, during the last years of his life, and was in habits of intimate and cordial association with Prof. Agassiz.

This distinguished gentleman died two years ago. He left by will his large, choice, and most valuable collection of engravings to Harvard College, together with a fund of sixteen thousand dollars to defray the expense of cataloguing and preserving them. But the most important of his legacies for public objects is that of fifty thousand dollars, as described in the extract from his will, quoted by William Gray, his nephew and executor, in a letter addressed to the corporation, dated Boston, Dec. 20, 1858, as follows:

"And also give, out of such surplus only, to Harvard College, or such other institution as you see fit, the further sum of fifty thousand dollars; the income to be applied to establishing and maintaining a Museum of Comparative Zoology; not to be appended to any other department, but to be under the charge of an independent Faculty, responsible only to the Corporation and Overseers. No part of said income is to be expended for real estate or the payment of salaries."

The conditions under which this donation has been bestowed on Harvard University are as follows:

"*First*, That the same be kept as a separate and distinct fund, and invested from time to time at the discretion of the Corporation, provided that no part thereof shall ever be invested in real estate, or in the shares or stock of any incorporated or joint-stock company.

"*Second*, No part of the income of said fund shall ever be expended for real estate or the payment of salaries.

"*Third*, The income is not to be subject to any charges of any nature, but the whole amount derived from the fund is to be applied to establishing and maintaining a Museum of Comparative Zoology at Harvard College.

"*Fourth*, Neither the collections, nor any building which may contain the same, shall ever be designated by any other name than the Museum of Comparative Zoology at Harvard College.

"*Fifth*, The Museum shall never be appended to any other department, but is to be under the charge of an independent Faculty, responsible only to the Corporation and Overseers.

"*Sixth*, The President of the College shall be the President of the Faculty, which shall be composed of four members besides the President. In case of vacancies in their number, other than that of President, the Faculty shall from time to time nominate to the Corporation persons to fill such vacancies; and if confirmed by the Corporation, such persons are to become members of the Faculty; if rejected, new nominations shall be made by the Faculty to the Corporation.

"*Seventh*, The Faculty are not to be at liberty to expend any part of the income of the fund, unless previously placed at their disposal by the Corporation.

"*Eighth*, The first Faculty shall consist of Rev. Dr. James Walker, President of the College, Professor Louis Agassiz, Director of the Museum, Dr. Jacob Bigelow, Professor Oliver Wendell Holmes, and Professor Jeffries Wyman.

"*Ninth*, In case of the loss of any part of the fund, so much of the income as may be requisite for this purpose shall be retained to make good such loss, provided that not more than one-half of the income shall be so retained in any one year.

"*Tenth*, That the Corporation enter this donation, with its conditions, upon their records, and vote to accept the same."

The conditions above prescribed are most judicious. The object for which the fund is established, in their nature cannot change. But there still remained other objects which imperatively demanded to be provided for. The collections of Professor Agassiz are at present in a small wooden building, which the torch of an incendiary might in an hour reduce to ashes, and thus annihilate the fruit of twelve years toil. Attention has been repeatedly called to this subject, and the announcement that Mr. William Gray, in the exercise of the discretion vested in him by his uncle's will, had decided to give the fifty thousand dollars for the support of the Museum, with the limitations already recited, seemed to be a sufficient reason for bringing the necessity of a fire-proof building again before the public. The matter was forcibly presented by Prof. Agassiz to the Visiting Committee of the Scientific School, in January. We give an extract from this document, which has been printed by order of the Overseers.

"I have laid out a plan which I will simply submit to you. I am afraid you will consider it extravagant, but if I understand rightly the aspirations of the young men with whom I am every day brought into contact, I cannot consider it over-sanguine, or doubt that the time is coming before long, when the scientific progress of the country will demand such an institution.

"My hope is that there shall arise upon the grounds of Harvard a Museum of Natural History, which shall compete with the British Museum and with the Jardin des Plantes. Do not say it cannot be done, for you cannot suppose that what exists in England and France cannot be reached in America. I hope even that we shall found a museum which will be based upon a more suitable foundation and better qualified to advance the highest interests of science than these institutions of the old world.

"But although I have sketched a plan for such a museum, I am nevertheless fully aware that, at the beginning, it must be carried out in a manner commensurate with the probable means that may be secured. Let us first erect a wing of that ideal museum, at an expense of perhaps $50,000, or, if that is too much, let us limit ourselves to such rooms as will give fitting shelter to the collections already on hand, and secure them from the danger of fire and other casualties. A spark of fire in this slight wooden building, where the collections are now heaped together, would be sufficient to destroy in half an hour the collections which it has cost me twelve years to amass, and which I can truly say is the most valuable collection for the student of natural history on this continent, and, in some of its classes, superior to any in the world. The mere possibility of unpacking what is already in our possession under this roof, crowded together in barrels and boxes, inaccessible to myself or the students, of displaying them to the public, and making them useful for study, will, I have not the slightest doubt, be a sufficient stimulus in the community to secure what will be needed to finish the structure and to render it worthy of the institution with which it will be connected, and the enlightened people who understand that in our age, culture is the

only true distinction among nations. One thing only should not be overlooked, that whenever any structure is put up for the museum, it should not be built in a corner where it cannot grow, but be placed on such grounds as will never be an impediment to its indefinite increase.

"In its present condition, the museum hardly furnishes me the specimens I require for my courses of instruction, for, in consequence of the daily accessions which are heaped upon those already crowded in this narrow space, it is often impossible to find what is wanted at the time, and it is out of the question to allow free access to the Museum in its present confused state, to any student not already trained in the manipulation of specimens. Had I six or eight rooms of the size of the two now at my disposition, I could at least make a fair beginning of a systematic arrangement, separate the duplicates from what is to constitute the collection proper, allow free access to the rooms for the public as well as the students, and thus create a more general interest for this establishment, while the students themselves would derive all the advantages which such a collection ought to afford them in their studies. At the same time, the separation of the duplicates from the collection proper would furnish ample materials for an extensive system of exchanges with other institutions of the same kind, by which the collection would at once be at least doubled in all its parts, and in some of its departments increased three or four times, and in some, even tenfold. The advantages of such a system of exchanges are very obvious, and my inability from want of room to separate the duplicates from the collection, has already been, for some years past, a check upon its increase. I hope, therefore, that as soon as it is fully understood, some remedy for this evil may be found.

"But even the possession of an appropriate building will not altogether put an end to our difficulties. The collection is already so large that it is impossible for me to take charge of it alone, even were I to give all my time to its care. For many years past I have already been under the necessity of having one or two, and at times even three assistants, who, at my private expense, have been, most of the time, engaged in taking care of the specimens. As I have nothing in the world but what I earn daily, such an expenditure has frequently been for me a source of unendurable anxiety, of which I wish to free myself, that I may hereafter devote whatever energy I may possess untrammeled to the higher interests of science. In this perplexity I have thought that a number of curatorships, (corresponding to the scholarships now existing in the university, which enable young men, whose private means are insufficient for such an object, to receive a college education) might perhaps be founded by some of our wealthy citizens, which would furnish a small income to students who have already taken their degree, and who, wishing to prosecute further their studies under my direction, might thus earn the means of remaining in Cambridge by assisting in the arrangement and preservation of the collection, as well as in making the exchanges. The position of the curators in the scientific school would thus be similar to that of the tutors in the undergraduate department. In a well organized museum there should be as many curators as there are branches in zoology, including embryology, paleontology and zoological anthropology. In the

course of time, the curatorships (to which should be attached the duty of delivering a certain number of lectures annually) may be endowed so as to afford the means of appointing special professors for each branch, and as soon as this is accomplished, our organization would be more perfect than that of either the British Museum or the Jardin des Plantes. Beside the curators, there should be one or two preparators, to mount specimens, and to make the necessary preparations required for the illustration of the specimens. It would also be desirable to have an artist attached to the establishment, who would have to make magnified drawings of such specimens as are too small to be at once studied by the natural powers of the eye; these drawings would be appropriate ornaments for the corridors, and at the same time assist in the courses of lectures which it should be the duty of every curator to deliver annually upon the special branches intrusted to his care."

The very able chairman of the committee, the Hon. John H. Clifford, made an earnest report, urging upon the Overseers and the community the importance of acting at once upon the suggestions of Prof. Agassiz. The interest which these communications immediately excited, was great and general, and steps were taken to carry out, or at least to commence the execution of the plan. Several meetings of the most distinguished and enlightened citizens of Boston have been held, and liberal sums have already been promised. A general subscription has been undertaken, with the certainty of success. Not only this, but the subject has already been brought before the Legislature, and there is strong ground to believe that a handsome appropriation will be made, from the moneys received by the State from the sale of the "Back Bay" lands. Governor Banks, in his annual message, called attention, in general but emphatic terms, to the value of the natural sciences, and has since shown a liberal disposition to favor this particular measure. The Hon. Charles Hale, Speaker of the House of Representatives—and one of the most rising young men in Massachusetts—is also understood to be a warm friend of the proposal. Other leading persons in the government look upon it with favor, and there seems little doubt that a majority of the Legislature will take the same enlightened view. F.

4. *Observations on the Genus Unio*, together with descriptions of new species, their soft parts, and embryonic forms, in the family Unionidæ. 96 pages 4to, with 29 plates; by Isaac Lea, LL.D. (From the Journal of the Academy Nat. Sci. Philad., 1858).—These researches constitute a volume, of which the first paper was read in Dec. 1857, and the remaining two in November, 1858. The embryonic form of the shell in the case of 38 species of Unionidæ is figured without details on one of the plates. The prevalent form is pouch-shaped, the height much greater than the length. In the last paper on new Unionidæ of the United States, numerous species are described and well figured. Dr. Lea observes that he has found the *Unio cylindricus* Say, *U. rubiginosus* Lea, and *Anodonta imbecilis* Say, sensitive to light, as if possessing some kind of visual organs, and that Prof. Haldeman had observed and published the same for the *Unio radiatus*. Mr. Lea's first publication on this point was in the Proceedings Acad. Nat. Sci. Philadelphia for February, 1857.

5. *On the Stratification of Vesicular Ice by Pressure;* by Prof. WILLIAM THOMSON, F.R.S., in a letter to Prof. STOKES, Sec. R.S., (Proc. Roy. Soc. from Phil. Mag., Dec. 1858.)—In my last letter to you I pointed out that my brother's theory of the effect of pressure in lowering the freezing point of water, affords a perfect explanation of various remarkable phenomena involving the internal melting of ice, described by Prof. Tyndall in the number of the "Proceedings" which has just been published. I wish now to show that the stratification of vesicular ice by pressure observed on a large scale in glaciers, and the lamination of clear ice described by Dr. Tyndall as produced in hand specimens by a Brahmah's press, are also demonstrable as conclusions from the same theory.

Conceive a continuous mass of ice, with vesicles containing either air or water distributed through it; and let this mass be pressed together by opposing forces on two opposite sides of it. The vesicles will gradually become arranged in strata perpendicular to the lines of pressure, *because of the melting of ice in the localities of greatest pressure and the regulation of the water in the localities of least pressure, in the neighborhood of groups of these cavities.* For, any two vesicles nearly in the direction of the condensation will afford to the ice between them a relief from pressure, and will occasion an aggravated pressure in the ice round each of them in the places farthest out from the line joining their centres; while the pressure in the ice on the far sides of the two vesicles will be somewhat diminished from what it would be were their cavities filled up with the solid, although not nearly as much diminished as it is in the ice between the two. Hence, as demonstrated by my brother's theory and my own experiment, the melting temperature of the ice round each vesicle will be highest on its side nearest to the other vesicle, and lowest in the localities on the whole farthest from the line joining the centres. Therefore, ice will melt from these last-mentioned localities, and, if each vesicle have water in it, the partition between the two will thicken by freezing on each side of it. Any two vesicles, on the other hand, which are nearly in a line perpendicular to the direction of pressure will agree in leaving an aggravated pressure to be borne by the solid between them, and will each direct away some of the pressure from the portions of the solid next itself on the two sides farthest from the plane through the centres, perpendicular to the line of pressure. This will give rise to an increase of pressure on the whole in the solid all round the two cavities, and nearly in the plane perpendicular to the pressure, although nowhere else so much as in the part between them. Hence these two vesicles will gradually extend towards one another by the melting of the intervening ice, and each will become flattened in towards the plane through the centres perpendicular to the direction of pressure, by the freezing of water on the parts of the bounding surface farthest from this plane. It may be similarly shown that two vesicles in a line oblique to that of condensation will give rise to such variations of pressure in the solid in their neighborhood, as to make them, by melting and freezing, to extend, each obliquely *towards* the other and *from* the parts of its boundary most remote from a plane midway between them, perpendicular to the direction of pressure.

The general tendency clearly is for the vesicles to become flattened and arranged in layers, in planes perpendicular to the direction of the pressure from without.

It is clear that the same general tendency must be experienced even when there are bubbles of air in the vesicles, although no doubt the resultant effect would be to some extent influenced by the running down of water to the lowest part of each cavity.

I believe it will be found that these principles afford a satisfactory physical explanation of the origin of that beautiful veined structure which Prof. Forbes has shown to be an essential organic property of glaciers. Thus the first effect of pressure not equal in all directions, on a mass of snow, ought to be, according to the theory, to convert it into a stratified mass of layers of alternately clear and vesicular ice, perpendicular to the direction of maximum pressure. In his remarks "On the Conversion of the Névé into ice,"* Prof. Forbes says, "*that the conversion into ice is simultaneous*" (and in a particular case referred to "*identical*") "*with the formation of the blue bands;* .... and that these bands are formed where the pressure is most intense, and where the differential motion of the parts is a maximum, that is, near the walls of a glacier." He further states, that, after long doubt, he feels satisfied that the conversion of snow into ice is due to the effects of pressure on the loose and porous structure of the former; and he formally abandons the notion that the blue veins are due to the freezing of infiltrated water, or to any other cause than the kneading action of pressure. All the observations he describes seems to be in most complete accordance with the theory indicated above. Thus, in the thirteenth letter, he says, "the blue veins are formed where the pressure is most intense and the differential motion of the parts a maximum."

Now the theory not only requires pressure, but requires difference of pressure in different directions to explain the stratification of the vesicles. Difference of pressure in different directions produces the "differential motion" referred to by Professor Forbes. Further, the difference of pressure in different directions must be continued until a very considerable amount of this differential motion, or distortion, has taken place, to produce any sensible degree of stratification in the vesicles. The absolute amount of distortion experienced by any portion of the viscous mass is therefore an index of the persistence of the differential pressure, by the continued action of which the blue veins are induced. Hence also we see why blue veins are not formed in any mass, ever so deep, of snow *resting* in a hollow or corner. * * *

6. *Thoughts on Matter and Force, or marvels that encompass us, comprising suggestions illustrative of the theory of the earth and the universe;* by Thomas Ewbank, author of "Hydraulics and Mechanics," &c. 154 pp. 18mo. New York, 1858.—There are many excellent thoughts in this little work. But we cannot subscribe to its main doctrines, that expansion is the only effective moving power in a forming earth; that the earth's heat is due to pressure from gravitation; and that gravitation is a means of preventing any decrease of the mean temperature of a globe

* Thirteenth Letter on Glaciers, section (2), dated Dec. 1846.

because heat is generated by pressure and by friction attending the circulation of the hot liquid. Expansion and contraction for a given change of temperature are equal in amount and also in mechanical power, and both may be sources of movements in the earth's crust. As regards the circulating liquid, the power causing the circulation is equivalent in amount of heat expended to the heat produced by the friction in the circulation, so that there can be no increase from this source. Since gravitation can produce no condensation except there be a loss of heat, it cannot be a means of augmenting the heat; and hence, whatever may be the amount at any moment, the sphere will still lose by radiation, and find its only possible means of compensation for the loss in external sources. The author touches on geological topics while no geologist, and therefore without being aware of the points that are to be met in the required explanations.

7. *Shower of Mud at Corfu.*—Dr. G. LAWSON describes a mud shower as having occurred at Corfu on the 21st of March, 1857. The day was squally and showery, and with the rain came down a light shower of mud which covered lightly the leaves of the trees and garden plants. Under microscopic examination the earthy material was found to consist mainly of quartz grains and not of minute organisms.

8. *Notes on American Land Shells, No.* 4; by W. G. BINNEY, (Proc. Acad. Nat. Sci. Philad., 1858, Nov.)—Mr. Binney in this paper gives a catalogue of American Terrestrial Mollusks, with full lists of synonyms, which will be found of great convenience to all interested in this subject.

9. *Memoirs of the Geological Society of Great Britain, and of the Museum of Practical Geology.* The Iron Ores of Great Britain. Part II, The Iron Ores of South Staffordshire; by J. BEALE JUKES, with various analyses, made under the direction of Dr. PERCY. 64 pp. 8vo. London, 1858.—The South Staffordshire iron works occur in an area of 50 square leagues about Dudley.

10. *Smithsonian Report for* 1857.—The Smithsonian Institution is doing for science what is done by a Royal Society abroad; and much more. For besides publishing elaborate papers and works which would fail of a publisher on account of the expense, it is giving activity to science over the land,—calling out zealous research, and full collections of observations and specimens, in explorations over the Rocky Mountains and the regions west,—making a gallery of Indian portraits, the Stanley collection being deposited there, with the prospect of its being purchased by government,—gathering a cabinet of the natural productions of the United States,—collecting a library of all the Transactions of foreign Societies and Journals, which is already remarkably complete and nearly as possible up to the date of publication,—eliciting and issuing Reports on different departments of science,—sustaining a series of lectures at Washington through the winter,—and making itself, for the great convenience of the country, a medium of communication in the way of publications, between the science of the two Continents. This Report gives a brief account of the publications and encouragements of researches and general progress of the Institution the past year; also lectures by Prof. Joseph LeConte and Prof. S. Alexander, communications on Meteorology, and a Translation of Dr. J. Müller's very valuable Report of recent progress in Physics, made by G. C. Schæffer.

It contains also the decision of the Board of Regents upon the charges brought by Prof. S. F. B. Morse (contained in Shaffner's Telegraph Companion in 1855) against Prof. Henry, implying his "consciously and willfully deviating from the truth and this too from unworthy and dishonorable motives" in his testimony respecting the claims of Mr. Morse touching the origin of the electro-magnetic telegraph. The charges were of so gross a character, that Professor Henry, under a sense of the responsibilities of his position as Secretary, deemed it incumbent on him to bring them before the Board. The report of the Committee of investigation. pronounces the charges unsustained. Prof. Henry follows the report with a history of the discoveries that prepared the way for the telegraph.

11. *Straw Lightning rods.*—The power of straw as a conductor of electricity has been utilized in the south of France, no less than eighteen Communes in the neighborhood of Tarbes having been provided with conductors composed of straw. Experiments show that an electrical shock sufficiently powerful to kill an ox may be discharged by a single straw.—*Athen.*, *No.* 1630.

12. *Tschudi.*—Dr. Tschudi, the well-known traveller, has just returned from his last journey to Peru; the results of which will be submitted shortly to the public.—*Ib.*

OBITUARY.—*Death of William C. Bond.*—We are pained to announce the death of WILLIAM CRANCH BOND, Esq., the director of the Astronomical Observatory of Harvard College. He died at Cambridge, Mass., Jan. 29, 1859, aged 69. He was born in Portland, Me., Sept. 9, 1789. Before his appointment to the Cambridge Observatory, he had devoted himself with much industry, talent and success, not only to astronomical observations, but to the construction and improvement of optical instruments, in every detail of which he was well informed and practically skillful. Having gained a reputation as an observer at his private observatory in Dorchester, he was called to the charge of that in Cambridge, in 1839, before any buildings were erected. The great telescope was mounted June 24, 1847. In connection with his sons, he has used that great refractor with important results, in observations of the fixed stars, the nebulæ, and the planet Saturn. To his practical skill observers owe a piece of mechanism, called the "Spring Governor," by which time is visibly measured to a small fraction of a second. To the same skill in applying scientific knowledge to mechanical means was in a large part owing what is known in Europe as the "American method" of recording astronomical observations by electro-magnetism. He has been engaged with encouraging success in experiments for taking photographs of the stars by a camera attached to the great telescope. Before his appointment at Cambridge he was employed by the U. S. Government in making astronomical observations in connection with those of the South Sea Exploring Expedition. Mr. Bond's talents and acquirements as a skillful astronomer were duly appreciated not only in this country but also in Europe. In 1842 the honorary degree of Master of Arts was conferred on him by Harvard College. He was a member of the American Academy of Arts and Sciences, of the American Philosophical Society, and of the Royal Astronomical Society of London. By his death the College is deprived of a highly valued officer, and the scientific community of one of its most gifted and accomplished sons.—*Boston Daily Advertiser.*

Synopsis of the Report on Zoophytes; by JAMES D. DANA. 180 pp. 8vo. New Haven, 1859; containing descriptions of all the species in the Author's original 4to. Report, which is out of print.

H. L. BOWDITCH: Address on the Life and Character of James Deane, M.D., of Greenfield, Mass. 46 pp. 8vo.

Lieut. J. C. IVES: Colorado Exploring Expedition, Preliminary Report to Captain A. A. Humphreys, Topograph. Engineers. 12 pp. 8vo.

J. CASSIN: Mammalogy and Ornithology of the United States Exploring Expedition under Captain Wilkes, U. S. N., 1838–1842. 1 vol. 4to in 466 pages, with a folio atlas of 53 colored plates, 11 of mammals and 42 of birds.

F. T. CONINGTON: Handbook of Chemical Analysis. London: Longman & Co.—The author adopts the notation of the Laurent school.

Sir R. I. MURCHISON: Geological Map of England and Wales, 16 inches by 14. London: E. Stanford. 5s.—7s. mounted in case.

ANDREW C. RAMSAY: Geological Map of England and Wales, 36 in. by 42. Scale 12 miles to the inch. London: E. Stanford. 25s. in case, 30s. on rollers.

KNIPE: Geological Map of Scotland including the Shetland and Orkney Islands. London: E. Stanford. 25s. mounted in case.

G. R. GREENOUGH: General Sketch of the Physical and Geological features of British India. Size 80 in. by 68, scale 25 miles to 1 inch. London: E. Stanford. 4l. 4s. on a roller and varnished or folded in a case.

LAKE PRICE: A manual of photographic manipulation; treating of the practice of the art in its various applications to nature, with 50 engravings on wood. London. 6s. 6d. J. Churchill.

J. RUSSELL HIND: An Astronomical Vocabulary. London. 1s. 6d. J. W. Parker & Son.

G. W. LOWRY: Atlas of Physical and Historical Geography. Engraved under the direction of Prof. Ansted and Rev. C. G. Nicolay. London. 5s. J. W. Parker & Son.

JOHN MATTHEW JONES, Esq., assisted by Major J. W. Wedderburn and J. L. Hurdis, Esq.: The Naturalist in Bermuda; a sketch of the geology, zoology, and botany of that remarkable group of islands, together with meteorological observations. London: Reeves and Turner.

H. P. PRESCOTT: Tobacco and its Adulterations. London: Van Voorst.—A work giving the means of distinguishing the kinds of leaves mixed with tobacco by microscopic and botanical evidence.

MILNE-EDWARDS, H.: Leçons sur la physiologie et l'anatomie comparée de l'homme et des animaux. T. IV. 1re parte. In–8. *Victor Masson.* 6*fr.*

LEUCKART, RDF.: Zur Kenntniss des Generationswechsels und der Parthenogenesis bei den Insekten. Mit 1 lith. Taf. *Frankfurt a. M.*, 1858. Meidinger Sohn & Co. 8°, IV, 112 pp.

F. RITTER VON HAUER and FR. FOETTERLE: Geologische Uebersicht der Bergbaue der Osterreichischen Monarchie, mit einer vorwort von WILHELM HAIDINGER. 222 pp. 8vo. Vienna, 1855.

PROCEEDINGS ACAD. NAT. SCI. PHILADELPHIA, 1858, Nov. and Dec.—p. 188, Species of Cristatella from near Newport, R. I.; *J. Leidy.*—p. 190, Note on the *Orthis insculpta* of Hall; *Christy.*—p. 191, Birds of Hakodadi, collected by Dr. A. A. Henderson, U.S. N.; *J. Cassin.*—p. 197, Notes on American Land Shells, No. 4; *W. G. Binney* (see p. 300).—Plate 3 of the new Lepidopter, *Argynnis astarte* Fisher, well colored.—p. 218, Hadrosaurus Foulkii, Reptile from the Cretaceous of New Jersey; *J. Leidy, W. P. Foulke, I. Lea.*—p. 223, Ichthyological Notes; *C. Girard.* —Prodromus, &c. (Crustacea of the North Pacific Expedition) Anomoura; *W. Stimpson.*—p. 253, New Genera and species of N. American Lizards in the Museum of the Smithsonian Institution; *S. F. Baird.*—p. 256, Remarks on the Lower Cretaceous beds of Kansas and Nebraska together with descriptions of some new species of Carboniferous fossils from the valley of Kansas river; *Meek* and *Hayden.*

ANNALS OF THE LYCEUM OF NATURAL HISTORY OF NEW YORK, Vol. VI, Sept. 1858. —p. 303, Synopsis of the Genus Achatinella; *W. Newcomb.*—p. 336, Remarks on certain species of North American Helicidæ (continued); *T. Bland.*—p. 362, Synopsis of the Fresh Water Fishes of the Western portion of the Island of Trinidad, W. I.; *T. Gill.*

THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. XXXII.—*On the Fluctuations of the Water Level at Green Bay, Wisconsin;* by CHAS. WHITTLESEY, of Cleveland, Ohio.

THE town of Green Bay is situated at the mouth of the Fox (or Neenah) river. As far up the river as "Des Peres," or about five miles, the water is dead and deep enough for navigation by sail vessels. The first rapid is at Des Peres, the seat of the earliest French mission on the Fox river, taking its name from the Jesuit fathers, of whom relics yet remain. Here a dam and lock have been built as part of the improvement of the river.

Movements of the waters at the mouth and along the still water portion of the channel are so frequent and so marked as to attract the attention of travellers and residents from the days of the Jesuits to our own. The current is seen flowing rapidly up stream as far as the rapids almost every day, and sometimes more than once or twice. With the influx is a rise sometimes very small, at others reaching one and even *two* feet, as the following tables show.

Notwithstanding the curiosity excited by this series of movements, very few measurements have been made. The early numbers of this Journal contain, I believe, all the observations heretofore made, but I have not the advantage of referring to them. Those which I now present are by no means complete, but may be of some value in discussing the question of lunar influence.

In the month of August, 1858, at my request, D. UNDERWOOD, Esq., cheerfully consented to make hourly observations so far as it could be done consistently with his occupations. Mr. Underwood is the observer at Green Bay for the Smithsonian Institution at Washington: a capable and faithful person, having a strong inclination for all subjects connected with natural science.

The bay which has given its name to the town, is on an arm of Lake Michigan, about 120 miles in length, and its greatest width about 20 miles. It opens into the lake not so much by direct channels as by side ones among islands that lie across the mouth, which is about 25 miles in width. In general form it resembles the half-fledged wing of a bird attached to its body by its side and at the largest end. The general direction of its axis or middle line is northeast by north, making an acute angle with the coast line of Lake Michigan. A narrow peninsula coming to a point at the "Port-des-Morts," lies between the bay and the lake, rising from 100 to 200 feet above the water level. The western shore of the bay is low and swampy; winds that blow across the bay from the northwest, therefore, act more powerfully on its waters, locally considered, than those from the opposite quarter over the bluffs of the eastern shore. At Green Bay and Fort Howard the shore lines approach to a point.

From Mr. Underwood's register I have to a considerable extent condensed the readings so as to express them in substance, in the form of curves. At the broken or dotted portions the observations are wanting. We assumed an arbitrary line or plane of reference intended to be above the floods of the year 1858, and called this *zero*.

Constructing a water-gauge, marked to half inches, it was nailed to a pile at the south side of the dock of Day & Brothers, its zero corresponding with the assumed line, the figures reading downwards. The readings were made hourly during the day, but were necessarily deficient for most of the nights.

By means of the tables and of the diagram [see Plate] the written portion of this article is very much abridged.

Two columns at the left show the time of high water, and approximately the hour of the moon's southing on the same day. The period which should elapse between the meridian passage and high water is subject to so many collateral influences that it is not determined without long continued observations. But for the same place it must be nearly constant, and a tide arising from that cause would therefore occur with regularity. The space occupied by the corresponding strength and direction of the winds, as observed locally, exhibits only their prevailing or general condition.

On the 22d of September only four hours passed without observations, but most of the days began at 5 A. M. and closed at 7 P. M.

The position of Green Bay is more favorable for detecting a lunar tide, if it exists, than a point on the shore of the lake. In inland seas of much greater size, such as the Baltic and the Mediterranean, which connect directly with the ocean, only a small tide is observed. I am not aware that it has been noticed in the Caspian and the Black Seas. On the open sea the rise and fall is slight, ranging from two to three feet only.

The great vertical range of tides in our harbors on the coast arises from the configuration of the shore and the form of the ocean bed. The swell is augmented of necessity as it is driven into bays and inlets with converging shores and shallow water. At the mouth of the Bay of Fundy the tidal wave has thus been raised to 10 and 12 feet, and running into the bay it attains a height of 30 and 40 and at spring tides of 60 feet. The contour of Green Bay is much the same. A swell of two inches at the Port des Morts when carried on and compressed between the converging shores should produce a rise of six or eight inches.

It has been long known that on the western lakes there is a land and water breeze occurring daily, as happens on the coast of the ocean. Its regularity may be disturbed by storms, but without these a breeze begins gently to draw off shore between seven and eight in the evening, sufficient to take vessels out of harbor. About ten in the morning following, the reverse is witnessed. In the cold months, a sluggish, but damp and chilly, current of air moves from the water towards the land. It is productive of congestion of the skin, oppresses the lungs, produces torpor in the animal system, and increases the flow of blood to the head. The evening breeze has the opposite effect. Without assuming, in the present state of the observations, that the moon produces no perceptible effect on the waters of the lakes, I offer some deductions that I think follow from the register of Mr. Underwood, showing a direct connection between the winds and the rise and fall at Green Bay.

This effect is complicated but may be philosophically explained. A land breeze commencing at the Port-des-Morts, would in due time press the waters into the bay, more or less according to its duration and force. A water or off-land breeze would depress the water, but owing to the form of the bay and the coast the effect should be less in amount. These breezes are regular.

The winds and gales that occupy the whole surface of the lake, are irregular in their occurrence. They overcome in many cases the minor currents that flow and reflow across the shore line otherwise daily, to and from the land. These limited currents arise from the unequal heat of the day and of the night. Suppose a powerful norther is raging on the lake, driving the navigator towards its southerly extremity, where the chances of

shipwreck are at least equal to those in favor of his escape. The gale carries the water along with it, and at Chicago and Michigan City there is a rise in the surface of three to four feet. At the Beaver Islands and at the Port-des-Morts there is a corresponding depression. The waters of Green Bay must therefore tend to flow out. But the same wind operating within the basin of the bay, resists the flow of water to the north, and diminishes the result that would otherwise follow, depressing the surface at the town of Green Bay. A gale from the east and northeast acts in *favor* of a rise, both directly and indirectly. Its tendency is to force more water into the bay and to retain what is already there. Accordingly we should anticipate very high water under the influence of prolonged northeasterly winds. But even here as I witnessed at the Oconto River, November 2d and 3d, 1858, a reflux may occur while the wind holds in the same quarter. On the 2d at noon the water was at its greatest known height. At noon on the 3d it had fallen 12 inches although the same gale continued.

Gales from the south and southwest should produce hydrographical effects the reverse of those from the north, and have the same double action. If they continue long, the water in the lake is raised at its northerly end, and tends to flow into the bay, raising its surface. Within the area of the bay, however, the tendency is to drive water out of it, and to depress the surface at the mouth of the Fox River. Here is again the question of the resultant of opposing forces.

The diagram and its attendant columns show a direct connection between the northeast winds and the extreme floods of the season. The 2d of July, the 20th, 21st and 27th of August, the 8th, 9th and 24th of September, and the 2d and 3d of November are cases of this sort.

But to present this part of the subject more fully I insert a table of the extremes of both the ebb and the flood during 29 days which have the fullest record. [See table, next page.]

From this table it appears that in all cases where the force of the wind during the day reached 2 and over, there was a *difference of level* of eight inches or more, with the exception of Sept. 1st, when it was only 6½ inches. The wind that day was southerly. There is one case (Sept. 9th) of a range of 8 inches where the force of the wind (northeast) was only 1. In another case (Sept. 25th), where the record of the previous day was not taken, there was a fluctuation of 10½ inches without any wind observable at the town of Green Bay. Observations on the coast are necessary to elucidate such cases. On the 25th also there was a range of 9 inches under similar circumstances.

By the registers, there were 17 days in which the flood occurred *twice*, having two maxima, and 15 days with but one.

High water occurred in the forenoon 18 times and in the afternoon the same number. Low water took place in the forenoon 9 times and in the afternoon 12. With the wind northerly, of an east and west line, high water occurred 12, and with it southerly 5 times. There was a flood in calm weather 10 times, and an ebb 8 times.

Extremes of fluctuation for August and September, 1858.

	HIGH WATER.		WIND.		LOW WATER.		WIND.		Daily range.
	Hour.	Below zero.	Direction.	Force.	Hour.	Below zero.	Direction.	Force.	
Aug. 19.	6 A. M.	3 inches.	Calm.	0	2 P. M.	12 inch.	S.W.	2	9 inch.
" 20.	6 A. M.	3½ "	"	0	5 "	16½ "	N.	2	13 "
" 21.	9 P. M.	4½ "	W. by N.	1	12 M.	13¾ "	W.	2	9¼ "
" 22.	6 A. M.	0½ "	N.	1	2 P. M.	12 "	N.	1	11½ "
" 23.	6 "	4 "	W.	1	12 M.	14½ "	W.	1	10½ "
" 24.	6 "	9 "	Calm.	0	1 P. M.	15½ "	N.	1	6½ "
" 25.	7 "	8 "	S.	1	2 "	13 "	S.	1	5 "
" 26.	6 "	7 "	Calm.	0	3 & 5 P. M.	13 "	S.	1	6 "
" 27.	6 & 9 A. M.	1 "	N.	3	2 & 3 "	11½ "	N.	3	10½ "
" 28.	5 P. M.	1 "	N.	2	11 & 12 P. M.	9 "	N.	2	8 "
Sept. 1.	7 & 9 A. M.	8 "	S.	1	5 A. M. & 2 P. M.	11 "	S.	1	3 "
" 2.	6 P. M.	5 "	S.	2	4 P. M.	16 "	S.	3	11 "
" 3.	9 A. M.	11 "	S.	2	1 "	20½ "	S.	3	9½ "
" 4.	5 P. M.	9½ "	S.W.	1	9 & 10 A. M.	20 "	S.W.	2	10½ "
" 6.	4 "	7½ "	S.	2	1 P. M.	14 "	S.	2	6½ "*
" 7.	5 "	5 "	N.	1	12 to 2 P. M.	14 "	N.	3	9 "
" 8.	6 A. M.	3, A	N.	2	4 P. M.	18 "	Calm	0	16 "
" 9.	8 A. M. to 7 P. M.	5, B	N.E.	1	5 A. M.	13 "	N.E.	1	8 "
" 10.	5 & 6 A. M.	5 "	W.	1	4 & 5 P. M.	17 "	W.	2	12 "
" 13.	11 A. M. & 7 P. M.	9 "	S.	1	5, 6 & 7 A. M.	13 "	Calm	0	4 "
" 14.	12 M.	8 "	Calm.	0	5 to 9 A. M.	10 "	"	0	2 "
" 15.	5 A. M.	8 "	"	0	12 M.	11½ "	"	0	3½ "
" 16.	5 "	7½ "	"	0	11 A. M. to 1 P. M.	13 "	"	0	6½ "
" 20.	6 P. M.	6 "	S.W.	2	10 A. M. to 12 M.	18 "	S.W.	3	12 "
" 22.	7 "	3 "	Calm.	0	2 A. M.	13½ "	Calm	0	10½ "
" 23.	7 "	2 "	"	0	2 P. M.	14 "	N.	1	12 "
" 24.	3 A. M.	4½ A	N.E.	4	7 "	15 "	Calm	0	19½ "†
" 25.	3 "	3 B	Calm.	0	6 A. M.	12 "	"	0	9 "
Nov. 2.	2 P. M.	15 A	N.E.	Gale.	‡				

Abstract of the number of times high and low water occurred under the influence of different winds.

	North.	N.W.	West.	S.W.	South.	East.	N.E.	S.E.
High water, - -	6 times	0	2	2	5	0	10	0
Low water, - -	7 "	0	3	3	6	0	8	0

* High at 7 and 8 A. M. and 5 P. M. ‡ At 7 A. M., 12 A, at 12 M. 14 inches, A.
† Gale from N.E. began at midnight, 23d and 24th.

From the 1st to the 16th of September inclusive, the moon's southing occurred within the hours of the readings for high and low water. Of these days, on the 1st and 3d the flood arrived within *two* hours after the passage of the moon. On the 2d, 4th, 6th and 7th from 5 to 11 hours afterwards. On the 8th, 9th, 10th, 12th, 13th, 14th, 15th and 16th from 5½ to 11½ hours before southing, but on the 9th and 13th there were two maxima 3 to 5½ hours after. From the 12th to the 15th inclusive, four days, the weather was continually calm at the place of observation. The variation of level during those days was small, the mean being *four* inches, the least 2, and the greatest 5½ in. This was the most favorable opportunity for the appearance of a lunar tide. The period of conjunction passed on the 7th, and consequently the calm weather all came within the first quarter. Neither on those days or during the most quiet periods embraced in Mr. Underwood's register, do I discover evidences of a flux and reflux that I can connect with the moon's motions.

Perhaps more perfect and prolonged observations might disclose such evidence. No station can be found better calculated to test the question fairly, provided simultaneous observations are made at the mouth of the bay. It is to be hoped the attention which the officers of the United States Topographical Corps are now giving to the subject of lake fluctuations will lead to such observations.*

Art. XXXIII.—*On Parthenogenesis*;† by E. Regel.

Thousands of accurately observed cases bear evidence that an embryo can be developed in a seed only under the influence of fecundation. A few naturalists did, indeed, up to the beginning of the present century, deny the necessity of fecundation, but these were solitary voices (Schelver and Henschel‡). The theory of fecundation, the practical proof of it (the production of hybrids), was assumed to be a settled fact, and up to our own time underwent a continually fuller development.

A few voices were here and there raised, not against the theory of fecundation generally, but for the proposition that in certain plants a true embryo might be formed without fecundation, where this was hindered; in other words, it was assumed that, "*Normally, the embryo is developed in a seed only under the influ-*

* See an Appendix to this paper in the miscellanies beyond.

† Botanische Zeitung, Oct. 8, 1858. Translated by Arthur Henfrey, F.R.S., &c. Cited from the Ann. and Mag. of Nat. Hist. xiv, 100.

‡ Henschel, von der Sexualität der Pflanzen, nebst einem historischen Anhange von Dr. F. J. Schelver. Breslau.

ence of fecundation. But if the fecundation is prevented, in certain cases an embryo may be nevertheless developed." Strictly speaking, therefore, it was assumed in this statement that the male sexual organs of plants were wholly superfluous structures.

But this assertion was made always in reference only to particular plants, and indeed to the same with which Spallanzani had experimented in the year 1786, namely hemp and spinach.* How inexact Spallanzani's observations must have been, appears from the fact that he obtained ripe seeds even from basil from which he had removed the anthers, also from watermelons, &c.

On these latter and similar plants, on which it is easy to operate, there exist a number of direct experiments to show that the prevention of fecundation hinders the production of seeds capable of germination; these and similar observations have been repeated subsequently by persons who were wholly destitute of the knowledge requisite for an exact experiment. On the other hand, Bernhardi, an otherwise very exact observer, repeated Spallanzani's experiments on hemp,† and obtained exactly similar results.

This question then sank to rest again; Bernhardi's observations were explained by assuming inaccurate observation, or the formation of a bud in the seed.

In 1841, J. Smith‡ made known his observations on the production of seed by *Cœlebogyne ilicifolia*, which was stated to perfect all its seed without any fecundation. At the same period Lecoq asserted the occurrence of parthenogenesis in a host of plants. From his superficial observations he drew the conclusion that all annual plants with separate sexes could form perfect seeds without fecundation. By such a wise contrivance, nature prevented the dying-out of such plants.

Cœlebogyne is still in very few hands in flowering condition. So far as we know, it has not been observed, from the period of flowering to the ripening of the fruit, by any German botanist. Observations on the so-called unfecundated seeds, such as were made by Radlkofer, Klotzsch, and A. Braun, can have but a conditional importance. That all has not been seen that may be seen, in this plant, is evident from the fact that while Klotzsch demonstrated, from the formation of the seed of this plant, that it contained not an embryo at all, but a bud, Radlkofer and A. Braun are of the opposite opinion. The latter, however, made a most important observation, still unexplained by him, namely, that he found a pollen-grain with a pollen-tube on the stigma of *Cœlebogyne*.

* Spallanzani, Expériences pour servir à l'Histoire de la Génération des Animaux et des Plantes. Geneva, 1785.

† Otto und Dietrich, Allg. Gartenzeitung, 1839, pp. 327, 329.

‡ Trans. Linnæan Society of London, 1841, p. 509.

In leaving *Cœlebogyne* to one side, since those only are competent to speak of it who have had an opportunity to observe it, it may be noticed that this plant has been the cause of the resuscitation of the question as to the possibility of parthenogenesis in the vegetable kingdom, and this the more that a similar phenomenon in the animal kingdom was simultaneously asserted by von Siebold. Naudin and Decaisne in particular took up again the earlier experiments on *Spinacia* and *Cannabis*, adding to them a number of other plants. The result of their experiments was, that female plants of *Spinacia*, *Cannabis*, *Mercurialis annua*, and *Bryonia dioica* bore perfectly ripe seeds when they had been sufficiently guarded against the accidental influence of the pollen of male flowers. According to M. Naudin's report, neither he nor M. Decaisne could discover male flowers among the female flowers, which were borne in great numbers. On the other hand, *Ricinus communis* and *Ecbalium Elaterium* bore no seed when all the male flowers were removed before they opened.

Naudin concluded from his observations "*that only diœcious plants are capable of perfecting seeds without fecundation, while monœcious plants perfect their seed only under. the influence of fecundation.*"

Radlkofer, from the cases made known by Naudin and Smith, deduced the further law, "*that ovaries which perfect their emhryos without fecundation retain their stigmas much longer in a fertilizable condition than is the case when the embryo originates in consequence of regular fecundation.*"

As usual, the majority of naturalists have accepted these statements, promulgated as certain facts. The very circumstance that, in the supposed discovery, all those laws which we have invariably recognized in reference to the origin of embryos are opposed face to face—the attraction of the wonderful, which in these days possesses a powerful charm,—has brought many over to the party who believe in a parthenogenesis.

The author of this notice has expressed, in the last year or two ('Bonplandia,' 'Gartenflora'), his modest doubt as to the accuracy of the experiments of Naudin and Decaisne, which served as the basis of an hypothesis of so great weight.

An objection arose in the outset, from the fact that the result was obtained only in small-flowering plants which developed a mass of flowers in every leaf-axil, while large-flowering plants, like *Ricinus* and *Ecbalium*, bore no seed when fecundation was prevented. Still more striking was it, that, of plants known to be polygamous, only female plants were mentioned, and an assurance was given that no male flowers were observed upon them.

I have in the present summer repeated the experiments made by Decaisne and Naudin. Although they are not yet quite concluded, they have afforded me proof that Decaisne and Naudin

have observed but superficially, and that neither *Spinacia* nor *Mercurialis* are to be included among plants which can furnish proof of parthenogenesis.*

Plants of *Spinacia*, *Mercurialis annua*, and *Cannabis* were planted singly in pots; and the male plants were removed as they appeared, before the dehiscence of the earliest anthers. The female plants were kept in a place where no pollen from similar plants could have access to them. As soon as the first flowers were perfectly developed, they were cut away so as to leave only a few axillary inflorescences which could be easily examined. All newly-produced lateral branches, which were abundantly developed, were carefully removed, and the inflorescences of the plants experimented on observed daily with a lens. These observations refer, up to this period, only to *Mercurialis* and *Spinacia*, as *Cannabis* has not yet unfolded any flowers.

Mercurialis.—One of the female plants was placed in a different locality, where it grew freely without being cut. This plant has now set abundance of fruit, which will doubtless bear perfect seeds with embryos. But on examination it was found that solitary perfectly developed male flowers were produced in the axillary tufts of flowers, as can be testified by MM. Körnicke, Rach, and Maximowicz, to whom I showed them. How this escaped the observation of MM. Naudin and Decaisne, is beyond my comprehension.

Two plants of *Mercurialis* were cut in and observed in the above described manner. Each of the few tufts of blossom produced a great number of female flowers. Here, again, solitary male flowers continually made their appearance, so that I have already removed more than twenty of them from each of the experimental plants. Even with the most careful observation, an absolutely conclusive result could scarcely be obtained with this plant; for the male flowers are only detected after they have opened, and therefore may have scattered pollen. I used my utmost endeavors to suppress the male flowers at the right time; and in fact hitherto neither of the experimental plants have set fruit, all the earliest developed female flowers having withered up. But if these plants should still set fruit, this must be attributed to pollen received from some of the male flowers.

Spinacia.—Difficult as it is in *Mercurialis* to neutralize the influence of pollen from adventitiously developed male flowers, it is still more difficult with *Spinacia*. All the experimental plants were cut in. I observed at first, in the axillary tufts of female flowers, solitary normally developed anthers, which projected over the female flowers. I removed them, and placed the plants

* I have not yet full observations upon *Cannabis*; but this will doubtless furnish similar results.

on which I had noticed them in a different locality. All my experimental plants appeared inclined to set seeds. I therefore placed all except one, on which the first flowers were beginning to unfold, in another situation, and continued the examination of this plant with redoubled attention, allowing in all only ten axillary tufts of blossom to come to perfection. All newly-produced lateral branches were necessarily broken off, as these at once developed new blossoms. First of all, I observed on this plant two stamens with anthers containing abundance of pollen. Placed under the microscope, this exactly resembled normal pollen. These stamens, however, did not arise (as I observed in *Chamærops* last year) from female flowers; but among the female flowers were scattered solitary stunted male flowers, which brought only one stamen, seldom more, to perfection. This fixed my attention. With the help of the lens, I soon saw, in the tufts of female flowers, isolated gland-like bodies, which I had taken at first for misshapen bracts. When I had dissected them out, I found that they were *sessile anthers,* developed in scattered abortive male flowers. These contained perfect pollen, as the above-mentioned gentlemen as well as myself can testify. These anthers are seldom perfectly seen, but are almost always partly covered up by the involucral scales of the flowers in which they arise, so that they may be easily overlooked or be taken for transformed bracts. In the isolated male flowers I usually found one sessile perfect anther, with several abortive; more rarely several perfectly developed anthers filled with pollen (all, however, sessile) exist in one flower. From one single axillary inflorescence I dissected out ten such male flowers with sessile perfect anthers. But as this had to be done on living plants under a lens, it could seldom be effected without injuring the anthers, by which pollen was always scattered. In such cases, I indeed removed the immediately adjacent female flowers; and the withering away of the earliest female blossoms was the result. At present, however, several appear to be swelling into fruit.

The very abundant development of axillary flowers here is of course a result of the cutting back of the plant and the removal of the lateral shoots which continually break out afresh from the axils, since the formative energy is wholly diverted to the development of flower-buds. A large proportion of the experimental plants did not bear this injury, and soon died away.

Whether the experimental plants of *Spinacia* and *Mercurialis* perfect seeds capable of germination, or not, these experiments have already fully convinced me that these two genera only develop perfect seeds under the influence of the pollen of adventitious male flowers, and that the only possibility of preventing fecundation is by daily repeated ob.ervation of every single

flower that unfolds, limitation of the growth of the plant to a few tufts of inflorescence, and rightly-timed removal of each male flower which makes its appearance. An observer who merely looks over a number of female plants with thousands of little flowers, cannot possibly obtain any result of the slightest scientific value. Surveying therefore the conclusions drawn from these experiments, it becomes evident that they have no authority.

That *Ricinus* and *Ecbalium* perfected no seed, evidently arises from the fact that in these plants the male flowers may be easily enough detected in time and removed, which can scarcely be accomplished with certainty in *Mercurialis* and *Spinacia*, since, from the small size and close packing of the flowers, these can only be detected when too late, even if these flowers are not altogether overlooked. There is no ground for making a distinction between monœcious and diœcious plants in this respect.

The same is the case with the stigmas. All the flowers of my experimental plants that were really protected from fecundation soon withered, stigma included. When, on the other hand, fruit was formed in consequence of fecundation, the stigmas persisted a long time, which is by no means wonderful, considering the fleshy nature of the stigmas of these plants.

As soon as *Cannabis* flowers, this plant shall also be subjected to careful examination. I may be permitted to notice beforehand, that the results of previous observations on *Cannabis* have been very varied. Some obtained no seeds on separate female plants (Linnæus obtained this result); others obtained abundance of seed. It seems to be indicated by this, that in *Cannabis* there occur individuals bearing only female flowers, and others which may resemble those of *Spinacia* or *Mercurialis*.

We possess plants of *Cœlebogyne;* but, unfortunately, none of them have yet flowered. Yet I am convinced that in this plant careful observation will clear up the matter. I may refer to the peculiar glands which surround the female flowers, with which solitary imperfect anthers might be easily confounded.*

Parthenogenesis certainly does not occur in plants with evident sexual organs.

Petersburg, Aug. 13, 1858.

* The author does not appear to be aware that the characters of the male flowers of *Cœlebogyne* are well known. M. Baillon has proposed the same unsatisfactory explanation of this case.—A. H.

Art. XXXIV.—*Terrestrial Climate as influenced by the Distribution of Land and Water at different geological epochs;* by Henry Hennessy, F.R.S., M.R.I.A., Professor of Natural Philosophy in the Catholic University of Ireland.*

Every point on the earth's surface is continually gaining and losing heat, and its actual temperature at any given moment depends on the difference between its gains and its losses. If the outer coating of the earth were exclusively composed of solid materials, terrestrial climate would depend principally on the heat gained from sunshine and the heat radiated into space. But as the earth is completely enveloped by an atmosphere, and partly surrounded by a liquid, its thermal conditions must be greatly influenced by the physical properties of these fluid coverings. While the heating or cooling of a solid follows the clearly defined and comparative well understood laws of conduction and radiation, the heating or cooling of gases and liquids is further greatly modified by the mobility of their particles. The changes of state which frequently take place in fluids, whether by evaporation or condensation, freezing or liquefaction, introduce agencies which still further complicate the study of their thermal relations.

When we study the thermal conditions of a liquid distributed over the terrestrial spheroid, it becomes manifest, that these conditions are influenced by the area, configuration, and physical structure of such portions of the solid earth as rise above the ocean and come in contact with the atmosphere, so as to constitute the surface of the dry land. Upon this matter I propose to develop certain views which are closely connected with those I have already published relative to the distribution of heat over such solid surfaces.†

2. When a surface, covered with ordinary soil, receives the rays of the sun, the heat thus acquired passes downwards, but on arriving at a very small depth its intensity rapidly diminishes. The solar heat which is thus received by the ground may, therefore, be considered as confined almost entirely to a thin superficial stratum. The air in contact with the soil becomes heated, expands, and tends to ascend: a circulation thus follows between the upper and lower strata of the atmosphere situated above the heated ground. During the night a different process takes place; for then the radiation of the soil causes its temperature

* Cited from the Atlantis, for January, 1859.

† On the Distribution of Heat over Islands, etc., Atlantis, No. ii, p. 396. See also the Note on the Laws that Regulate the Distribution of Isothermal Lines, No. iii, p. 201.

to fall below that of the superincumbent air; the coldest stratum of the lower portions of the atmosphere being in contact with the ground, the equilibrium of those above is not so much disturbed. Yet, even in this case, causes exist which tend to produce a series of actions and reactions between the upper and lower strata of air, by which a process of convection will be ultimately developed. These actions will be rendered especially remarkable if the soil is not bare, but covered with vegetation in the manner of the greater part of the dry land. This question has been fully treated by Melloni,* in his memoir on the nocturnal cooling of bodies. His general proposition, that "a body exposed during the night to the influence of a sky of equal clearness and calmness, is always cooled to the same extent, whatever may be the temperature of the air," is fruitful in important results. Thus is explained the great differences between the temperature of the day and night on land in the torrid zone. The intense cold observed during the night by Denham in traversing the great Desert of Sahara, the process of artificial freezing at Bengal, and the rain-like dews observed by Humboldt in the forests of South America, are all necessary consequences of the energy of the actions and reactions by which the outer coating of the earth loses the warmth it has acquired from sunshine during the day. Conversely, the almost constant temperature of the sea in tropical regions, by day and night, and the nearly total absence of dew on the rigging of vessels far removed from the land, clearly show the peculiar retentiveness of heat possessed by the water, and that, unlike the land, it does not readily part with whatever warmth it may have acquired from sunshine during the day. The cold southerly breezes sometimes observed in Egypt† during the winter months, when the air has passed over immense surfaces of sandy desert, present a striking contrast to the southwesterly winds which at the same season traverse the ocean and visit our shores. It appears, from a communication in the *Times* newspaper, dated Melbourne, November 15, 1858, that in South Australia, the coldest winds during the winter months, are those blowing from the northerly and tropical regions, while the warmest are those blowing from the pole. The former pass over extensive surfaces of heat-radiating, and therefore heat-losing land, while the latter traverse the heat-retaining ocean. In the summer (at least by day) the opposite phenomena are observed, of warm winds from the north and cold from the south. Combined observations on the wind, and on temperature, by day and night, would further elucidate a problem which, in the words of the writer, "cannot be solved

* Taylor's Scientific Memoirs, vol. v, pp. 453 and 530; and Annales de Chimie et de Physique, for February and April, 1848.

† Kaemtz Météorologie, French edit., p. 45.

without greatly adding to the stock of our knowledge." While the feeble conducting power of the solid portion of the earth's coating, allows but a small portion of the sun's heat to pass beneath the surface, so that whatever warmth is thus received on that surface during the day is readily radiated into space during the night, a liquid mass, similarly exposed to sunshine and subsequent nocturnal radiation, possesses peculiar properties which greatly influence the differences between its thermal losses and gains. The most important of these properties are, (1) the great capacity of water for heat, by which it gradually accumulates and slowly parts with whatever warmth it has received; and (2) the intermobility of its particles, by which exchanges of temperature in different parts of the liquid mass are essentially promoted.

Let us consider the effect of the sun's rays on a globe covered with water, and we shall soon perceive that a more energetic process than that of conduction accompanies the exchanges of temperature between the different portions of the fluid. The water which receives the vertical rays of the sun will be more heated than the waters which receive its rays at more oblique inclinations. Not only the amount of warmth received over a given area, but also the depth to which the rays of heat penetrate below the surface, depends upon the angles made by these rays with the vertical. Inequalities of surface temperature, depending on the latitude, the hour angle, and the sun's longitude, should thus result. The more heated waters would expand, and tend to spread over the cooler waters in other regions. Currents should arise from the mutual actions and reactions of the unequally heated portions of the fluid. The colder currents would usually tend to flow beneath the warmer, unless at temperatures approaching that of the maximum density of water, and thus a process of circulation would be established by which the temperature acquired by the superficial strata of the water should be ultimately propagated to a certain depth below the surface. Evaporation would also take place, and by the condensation of vapor a certain portion of the heat received by the water would be imparted, in the formation of clouds, to the superincumbent atmosphere.

If, as in the existing oceans, this water be salt, the inequalities of temperature producing inequalities of evaporation, will also produce diversities in the density of the water in different regions, and thus additional energy will be imparted to the process of circulation. The salter and heavier surface water will tend to sink into the colder liquid which lies beneath, and which shall naturally tend to take its place, by ascending upwards. The process of evaporation would cool the surface of the water; but, unlike that of radiation, it is not altogether a losing process

as far as the entire surface of the earth is considered; for it is sooner or later followed by condensation, whereby the greater part of the absorbed heat is again returned. When a piece of land or water parts with its heat by radiation into space, that warmth can never be restored to any part of the earth's surface; but whatever heat the water loses by evaporation, becomes latent in the vapor so produced, and is ultimately transferred by condensation to some other part of the globe; and hence evaporation does not constitute an agent in causing a diminution of general terrestrial temperature. Let us now suppose a sheet of water at the equator nearly surrounded by fixed boundaries, so as to form a species of immense lagoon. Its temperature, from the causes here referred to, will rapidly augment. The heat which it has acquired during the day shall have penetrated so deeply as to be incapable of being radiated backwards into space during the night, with the same facility as on the surface of a sandy plain or from the summits of a mass of vegetation. Its temperature should thus continue to accumulate up to a certain limit imposed by the conditions of evaporation, and it might ultimately attain a mean temperature superior to any which is now met at the surface of intertropical seas.

3. These views are strikingly illustrated by the phenomena accompanying the origin of the Gulf Stream. The mass of water which rushes into the Gulf of Mexico, along the southern shores of the Carribbean Sea, has already acquired a certain elevated temperature from the action of sunshine in the southern torrid zone in its passage from Cape St. Roque. In moving around the Caribbean Sea and the Mexican Gulf, these waters still continue under the influence of a tropical sun, and are constantly increasing in temperature. The islands and coasts which they happen to bathe, have no part in directly promoting this augmentation. On looking over the isothermal chart of the Caribbean Sea and Gulf of Mexico, prepared by Mr. Charles Deville,* it becomes manifest that in general the temperature decreases in going towards the land. In some places the mean annual temperature of the water close to the land is 24°·5 Centigrade; further out at sea it is 25°, and still further from the land it is 25°·5. In other places it gradually augments from 26°, in going from the land, up to 27°·4.† These results are unconnected with the influence of latitude, and they are still less explicable by the influence of centrifugal force, in driving the cooler and heavier waters towards the edges of the great current, in its semi-rotatory movement around the gulf. For in this case the law of decrease of temperature in going from the

* Annuaire de la Société Météorologique de la France, tom i, p. 160.

† Reduced to degrees of Fahrenheit's scale, these numbers, arranged in the same order as in the text, are 76°·1, 77°·0, 77°·9, 78°·8, 81°·3.

land, should not hold on approaching the coasts of large islands situated towards the centre of the moving mass of waters. But, in such instances, it is also manifested; for on the north and south coasts of the Island of Cuba we find the isothermal lines of 26°·2 and 26°·5, while the isothermals of 26°·7 and 26°·8 are situated outside them respectively.* In Mr. Deville's chart these are closed isothermals, similar to those which I have indicated on the surface of the British Islands; but as the lowest isothermals in my map are the most remote from the sea, those in his chart which exhibit the highest temperature are farthest from the land. It is thus apparent that the intertropical sea may become a storehouse of heat, by retaining much of what it receives from the sun, which, but for the physical properties of water, it would, like the intertropical land, lose by radiation into space. It is important to bear this conclusion in mind in any inquiries respecting the influence of the distribution of land and water on general climate, especially as the influence of the land seems to have been hitherto principally considered as a calorific agent.

The heating action of intertropical land has been so often discussed by writers on climate, that it is unnecessary to do more than to point out its principal agency in the production of aerial currents, by which exchanges of temperature may be promoted between different parts of the earth's surface.

In contrasting the mean temperature of the sea with that of the land in tropical climates, the want of nocturnal observations, as referred to by Melloni, is peculiarly felt. While the temperature of the one is nearly constant, that of the other is liable to considerable fluctuations; and, as our records are principally derived from diurnal observations, the results are probably too favorable to an excess of land temperature. This conclusion is confirmed by the results exhibited in Mr. Deville's map, and, in some measure, by the fact of the higher mean temperature of the entire oceanic covering of our planet compared to its atmospheric coating.

In comparing the calorific influence of the land on distant regions with the agency of the sea, it should therefore be remembered, that while the latter stores up heat and acts by night as well as by day, the action of the land is effective only as long as the sun's rays are impinging upon it.

4. Let us endeavor to apply these conclusions to the question of the influence of the distribution of land and water upon general terrestrial temperature. As the amount of solar heat received by any point on the earth's surface is a function of the latitude, it follows that the distribution of land and water at different latitudes must be studied in order to obtain its influence

* Equivalent respectively to 79°·16, 79°·7, 80°·06, and 80°·24 of Fahrenheit's scale.

on temperature. This distribution may be supposed to take place in an endless variety of ways, of which the following three cases are the most important:—

(1.) Preponderance of land towards the poles, and of water towards the equator. (2.) Preponderance of land towards the equator, and of water towards the poles. (3.) Equable distribution of land and water in polar and equatorial regions.

At the present day three-fourths of the earth's surface are covered with water, so that all the dry land has been truly characterized as an assemblage of large and small islands placed in a great ocean. If we suppose, with Sir Charles Lyell,* that in the question now under consideration, the proportion of sea to land is the same as at present, each of the above three cases is susceptible of two principal divisions, according as the islands composing the land happen to be few and large, or numerous and small. If all the dry land on the globe were collected into a single vast continent, the climatological conditions of the earth, all other things remaining the same, would be very different from what would take place if the land were broken up and spread out in numberless islands. Whatever may be the supposed distribution of land and water, it is manifest that its chief influence on the general temperature at the surface of our planet, should result from the action of aerial and oceanic currents.

In the first case above referred to, the belt of equatorial ocean would probably acquire a high temperature, and although the circumpolar islands would possess very rigorous climates in their interior, portions of their coasts might be washed by heat-bearing currents, just as the northwestern coast of Europe is washed by the Gulf Stream at the present day. The superiority of the mean temperature of the ocean might, in this case, be so great that the distribution of heat over the islands should present remarkable instances of the laws found to hold good in the British Isles, and almost all of the isothermals on the land would be closed curves.†

In the second case, the ocean would acquire much less heat from the sun, and it would exercise a cooling influence on the belt of intertropical land. But as whatever evidence we possess seems to indicate that intertropical seas owe their elevated temperature not so much to the influence of thermal exchanges with the air which has passed over the adjacent land, as to the direct influence of sunshine, we may conclude that upon the whole the heat-bearing currents would, in this case, be less influential than in that which has just been considered. The heated air flowing from the equatorial land should, by the agency of winds, in some

* Principles of Geology, chap. vii, 9th ed., p. 101.
† See Atlantis, No. ii, p. 399.

measure mitigate the temperature of the polar regions, but we have no reason for believing that this influence would be superior to that of the heat-bearing water currents in our former instance.

If now we suppose the land to be equally distributed in islands between the equatorial and polar regions, we shall have conditions more or less favorable to the existence of oceanic as well as of aerial heat-bearing currents, and it seems not impossible that, under such circumstances, the entire surface of the globe may enjoy the highest possible amount of general warmth by being best circumstanced for the accumulation, retention, and distribution of the heat it receives from the sun. In this case, as well as in the first which has been considered, warm currents from the equatorial seas might freely bathe the coasts of islands in higher latitudes, thus producing similar characteristic cases of insular climate. The mean temperature of such seas being higher than that of the air over the land, the isothermal lines of the islands should be partly or entirely closed curves, having shapes dependent upon the outlines of the islands. The greater the difference of atmospheric and water temperature, the more strictly should the isothermals conform to this law. Thus it is manifest that a nearly circular island, with a surface equal to that of Labrador, and lying in the same latitude, would present a much greater diversity of climate between its interior and its coasts, if the latter were bathed by sea water having a temperature of 80° Fahrenheit, than if that temperature amounted only to 40°. As the manner in which the warm air over the water would exchange its heat with the air over the land should take place undoubtedly by circulation, it would not be easy to assign a distinct law for the difference of temperature between the interior and the coast of the island; but it seems evident that this difference should, up to a certain limit, increase with the temperature of the heat-bearing oceanic currents. A group of islands situated in high latitudes, and surrounded by currents possessing a high temperature, while receiving but a small amount of heat from sunshine, should present a series of closed isothermals, and while their interiors would be cold, their coasts might enjoy an extremely genial climate.

5. If such conditions existed at former geological epochs, we may fairly expect to find some evidence of their existence by comparing the characters of the organized beings by which the interior and the coasts of such islands were inhabited. Such geologists as have hitherto studied the diversities in structure of the fossil remains which have come under their notice, appear to have attended principally to the climatic influence of the elevation of the interior parts of such islands. Professor Ramsay,*

* Memoirs of the Geological Survey of Great Britain, vol. i, p. 324.

in his memoir on the denudation of Wales, after pointing out the great elevation above the sea, which portions of that region had formerly possessed, calls attention to the resulting varieties of climate that must have prevailed. "If," he says, "the climate of our latitudes, when the coasts were washed by the new, red, and liassic seas, were tropical, as is generally supposed, still on the heights indicated on the vertical sections, we have ample space for tropical and temperate zones, each probably abounding in its own appropriate forms of life. And here, in connection with this subject, it may be remarked, that in Mr. Brodie's recent work, 'A History of the Fossil Insects of the Secondary Rocks of England,' it has been stated that, with certain exceptions, the minute size of the great mass of the insect remains seems to indicate a very cold, or at all events, a temperate climate."

This appeared to Professor Ramsay not to be in harmony with the other fossil evidence, which proves that most of the creatures whose remains are preserved in the strata of the secondary series inhabited a tropical climate. If the interior temperature of the land, whose inhabitants apparently existed under such different conditions of climate, depended not only on the coördinate of height above the sea, but also on that of distance from the coast, in the manner here described, a more complete explanation would be afforded of these remarkable phenomena. The discovery by Mr. Strickland, in the alluvial sand of Worcestershire, of the bones of a hippopotamus, accompanied, not only by the bones of other mammalia, but by twenty-three species of fresh water and land shells, of which nineteen are existing British species, seems to show that, even at a period so recent as that of the deposit from which these remains were taken, remarkable differences of climate may have existed over a comparatively small area of land.* The strong presumptions furnished by the fossil flora, and other evidences connected with the history of earlier geological formations in favor of the existence of numerous islands scattered over an ocean enjoying a tropical temperature, should lead us to expect more of such results as are here noticed, instead of feeling surprise at the discrepancies which they seem to exhibit.

6. I shall now attempt to illustrate some of the preceding general views from the actual condition of the earth's surface. The higher mean temperature of the northern, compared to the southern hemisphere, is clearly proved and universally acknowledged. This superior warmth is usually ascribed to the greater amount of land in the former compared with the latter. It has been apparently assumed that the surface of the dry land exercises upon the whole a far more energetic influence, in tending

* Geological Society's Proceedings, June, 1834, p. 94; and Lyell, p. 76, 9th edition.

to elevate the mean temperature of the earth, than the surface of the water, and this action is generally ascribed to the superior heat-absorbing power of land compared to water. Upon this assumption is mainly founded the beautiful and elaborate theory of geological climates, which Sir Charles Lyell first published in his *Principles of Geology*. Although Fourier had previously indicated the possible influences exercised upon terrestrial temperature by the physical conditions of the earth's outer coating, he had not given his views such a definite shape as to enable him to deduce any conclusions from them for the solution of the great problems of terrestrial physics which have so much occupied the attention of philosophical geologists.

If the conclusions of the theory now referred to be correct, it follows that predominance of land over water between the tropics, where an absorbing surface would be most advantageously circumstanced for acquiring heat, should result in producing the highest possible degree of general terrestrial temperature. On the contrary, the earth's general climate would be reduced to a maximum of coldness by a predominance of land towards the polar regions, and of water towards the equator. The views developed in this essay would appear to require some modification in these conclusions, and the first especially is not in perfect harmony with the results to which we have been led by such reasonings as I have here presented. Not only are there physical grounds for adopting a somewhat different conclusion, namely, that the most favorable condition for a generally high terrestrial temperature would be in a comparatively equable distribution of land and water over equatorial and extratropical regions, instead of a concentration of land in the former; but the study of the present relations of sea and land seems strongly to verify the views on which this conclusion is based.

If we look over a terrestrial globe, or a good stereographic projection of its surface,* we soon perceive that in the regions traversed by the ecliptic, and where, consequently, the sun's rays diffuse the greatest amount of heat over absorbing substances, land and water are distributed very evenly at both sides of the equator. Each hemisphere absorbs the greatest quantity of solar heat during the six months when the sun is vertical over some part of its surface, and I have found that the parallel of 7° 24′ receives the maximum amount of sunshine during the summer half year. In the northern hemisphere this parallel runs from the coast of Guinea through Central Africa; crossing the Indian Ocean, south of Cape Comorin, it passes through Ceylon across Malacca and the island of Mindano; thence through

* M. Babinet's homolographic maps are still better adapted for such comparisons as that now made. See Arago Astronomie, tome iii, p. 344, Report of the British Association for 1854, Trans. Sections, p. 112.

the Pacific, until it meets South America, the northern portion of which it traverses from a point near the Gulf of Panama to another between the mouths of the Orinoco and Esiquibo. In the opposite hemisphere, the parallel of maximum southern sunshine crosses Africa from a point north of St. Paolo de Loando to another near the Monfeca islands. It traverses a great part of Java, New Guinea, and smaller islands. It crosses South America almost on the line of greatest breadth, from near Truxillo to a point north of Pernambuco. On comparing the extent of land and water lying under the parallel of maximum half-yearly sunshine, it appears that the proportions are nearly the same in both hemispheres, although a very slight excess of land appears to lie under the southern, compared to the northern parallel.* Outside the torrid zone, the proportions of land and water belonging to each hemisphere respectively are extremely different: while nearly half of the surface between the pole and the tropic of Cancer is land, by far the greater portion of the area between the southern tropic and the pole is water. In the arctic and antarctic regions land and water alternate in nearly corresponding proportions. The great difference between the areas of land and water of the northern and southern hemispheres exists in the temperate regions. Upon the whole, it may be concluded, that there is a comparative predominance of land over water in the higher latitudes of the northern hemisphere, while the opposite condition holds in the southern hemisphere. If the presence of dry land in high latitudes is favorable to a cold climate, this condition appears to be more completely manifested in the northern than in the southern hemisphere; and if the presence of a certain amount of dry land within the tropics is favorable to a high temperature, that condition is almost equally well fulfilled at both sides of the equator.

Let us conceive all the land north of the equator to be submerged, and its place to be supplied, first, by a mass of land in the north tropical zone, exactly similar in area and configuration to that touching it in the southern zone. Let the arctic regions of North America, Nova Zembla, and Greenland be replaced by an island similar to Victoria Land, and let a few scattered islands replace the greater part of Asia, Europe and North America: we shall then have a globe with a considerable belt of equatorial land, while the polar and temperate regions will be occupied chiefly by water. We should thus have a state of things approximating much more to the conditions required for a high terrestrial temperature than the present distribution of land and water. Yet the distribution here supposed for both hemispheres would be precisely what at present exists in the colder of the

* See p. 328, Art. XXXIV, On the Laws which Regulate the Distribution of Isothermal Lines, § 5.

two; and we should thus have the paradox of warming the entire globe by modelling its warmer hemisphere after its colder. Unless the influence of Victoria Land as a refrigerator of the southern hemisphere should be greater than that of the immense masses of land in the northern parts of the new and old continents, this paradox would seem inexplicable on the theory under consideration. But it can be in some measure explained, if the agency of oceanic currents in storing up and transporting the heat acquired from sunshine be fully admitted. In the actual state of the earth's surface, the form of the basin of the South Atlantic Ocean, combined with other physical conditions, seems to determine the transfer of a great volume of heated water from the southern intertropical regions to the northern hemisphere, which, passing subsequently through the Caribbean Sea and Gulf of Mexico, acquires a still higher temperature, and ultimately confers its warmth on regions in high northern latitudes. From the direction of the currents of the Pacific, as laid down on some of Maury's charts, it is probable that a similar transfer northwards of heated southern intertropical water is effected in that great ocean as well as in the Atlantic. The general result is, that the southern hemisphere is not only deprived of a certain amount of the solar heat absorbed by its waters, but that the temperature of the northern hemisphere is augmented to a corresponding amount. But although the paradox alluded to may be thus explained, this result shows the danger of underestimating the agency of aqueous currents in connection with any theory of the distribution of land and water that may be proposed in order to explain vicissitudes of terrestrial climate.

7. In examining the consequences resulting from the suppression of the Gulf Stream on the climate of western Europe, with reference to the question of glacial action at former geological epochs, as has been done by Mr. Hopkins,* we need only direct our attention to what actually takes place at corresponding latitudes in the southern hemisphere. In these regions, there is not only an absence of such an active calorific agent, but even an abstraction of some of the heat due to them from the sunshine which falls upon a portion of their oceans, which heat we have seen is transferred to the northern hemisphere. Glaciers consequently descend to the sea, not only about the latitude of 54° S., as observed by Captain Cook, but even so close to the equator as 48° 30′ S., where they were noticed in great abundance on the western coast of South America by Mr. Darwin.† He even observed one instance of a glacier reaching the sea in the latitude of 46° 40′, which corresponds to that of Napoleon Vendée, in the west of France. The existence of glacial action in the

* Quarterly Journal of the Geological Society, 1852, p. 86.
† Voyage of Adventure and Beagle, iii, p. 282.

southern latitudes, equivalent to those of the temperate regions of western Europe, suggests the possibility, that by an inversion of the operating causes, the southern hemisphere might have enjoyed a milder climate at the same geological period when glacial phenomena were most completely developed north of the equator.

8. The results of our inquiry may be thus recapitulated:—

(1.) The physical properties of water appear upon the whole more favorable than those of the land, to the accumulation, retention, and distribution of solar heat throughout the matter composing the external coating of the earth.

(2.) Phenomena presented by intertropical seas at the present day, confirm and illustrate this conclusion.

(3.) The distribution of land and water most favorable to a general increase of terrestrial mean temperature, should, therefore, be such as would imply the existence of great intertropical seas and of groups of islands evenly distributed both within the tropics and in extratropical regions.

(4.) Such a distribution of land and water at former geological epochs, seems to be indicated by the results of observation.

(5.) The superior mean temperature of the northern compared to the southern hemisphere is probably due, not to the direct influence of the greater proportion of land in the former, but to currents which determine the transfer towards the north of a portion of the solar heat absorbed south of the equator.

9. While fully acknowledging the important influence which changes in the distribution of land and water may exercise on terrestrial climate, we are not precluded from studying the action of other causes, and of giving to them such weight as the evidences in their favor may render advisable. If, from the results of astronomical as well as of geological testimony, we are induced to believe that the earth has been for ages slowly cooling from a state of former incandescence, its climate during the earlier epochs of its physical history must have been more or less influenced by the heat thus passing outwards through its crust. However efficient, as applied to recent phenomena, we may find the theory of geological climates that explains the variations of the earth's superficial temperature by changes in the distribution of the liquid and solid portions of its outward coating, it seems by itself incompetent to rationally and consistently account for the very high temperature which must have prevailed during remote epochs of the earth's history. If we reject the evidence on which it has been concluded that the earth has slowly cooled from a fluid incandescent state into its observed condition, and admit that the earth's spheroidal shape was due to gradual and even existing causes, and not to the mechanical consequences of its primitive and universal fluidity, we shall arrive at a conclu-

sion which, on the supposition of the complete adequacy of superficial causes to explain all changes of climate, would lead to the inference that, from very remote epochs, the mean temperature of the globe should be increasing instead of diminishing. By rejecting the former fluid condition of the earth, we are compelled to account for its oblateness in the way attempted by Playfair, that is, by appealing to the influence of certain superficial actions coexisting with the phenomena of geological changes. But I have proved,* that if, from superficial causes, the earth's figure became gradually more oblate, the extent of polar dry land would gradually diminish, while that of equatorial dry land would, at the same time, tend to augment. Hence the very operations required to mould the earth's figure into the shape now observed, would, on this theory, point to a gradual increase in the efficiency of the physical conditions required for an augmentation of terrestrial temperature in proceeding from the most remote to the most recent geological epochs. But this is the very reverse of the conclusions deduced from the entire mass of geological inquiries; hence, as far as observation enables us to judge, we cannot explain by superficial actions alone, the twofold conditions of the spheroidal shape in the earth's figure, and the gradual diminution of its surface temperature from the earliest periods of geological history up to the most recent.

ART. XXXIV.—*Note on the Laws which Regulate the Distribution of Isothermal Lines;* by HENRY HENNESSY, F.R.S., M.R.I.A., Professor of Natural Philosophy in the Catholic University of Ireland.†

IN my essay on the Distribution of Heat over Islands,‡ I referred to another mode of treating the general problem of isothermal lines, by which similar conclusions are derived. As these conclusions are not only obtained by a method somewhat different from that already published, but as they are accompanied with a few additional remarks relative to their connection with the climatology of the globe, I may be permitted to present the following investigation as a development of a portion of the former inquiry.

2. The general problem, whose solution is here attempted, is to find the influence exercised by the physical structure and hydrographical relations of an island on the temperature at its surface. Let us consider an island having a certain definite figure,

* Proc. Royal Irish Academy, vol. iv, p. 333, and Journal of the Geological Society of Dublin, March, 1849.

† Cited from the Atlantis for January, 1859.   ‡ Atlantis, vol. i, p. 399.

and surrounded by an ocean so warm that we may at first neglect the influence on its climate of the difference of latitude of the several parts of its surface. Let it be supposed perfectly free from hills or mountains, land breezes will tend to blow from the interior, and sea breezes from every point on the coast. The disturbing action of other winds would sometimes greatly modify the directions and intensities of the land and sea breezes; but, abstracting for a moment the effect of such general winds, it is evident that the temperature at any point of the island due to the action of the warm air flowing in from the ocean, and of the cold air flowing from the interior, will be some function of its distance from the coast, and, consequently, the forms of the isothermal lines should have some relation to the coast line. If no other winds blew over the surface of the island but land and sea breezes, and these with uniform intensity and frequency at every point, the isothermal lines should be similar to the coast line. Let us now superimpose on the island a series of elevations sufficiently considerable to offer impediments to the currents of wind: the forms of the isothermal lines will undergo important changes. If these eminences are scattered around the coast, their influence shall be greater than if they were all concentrated towards the interior of the island; for, in the former instance, they will present a kind of barrier, more or less broken, between the air resting on the central plains and the air outside covering the ocean. The sea breezes will no longer exercise the same effect on the portions of the interior situated behind the mountains, while their influence will remain unchanged, or be even increased, on the portions still unscreened from the ocean. A corresponding change must, therefore, take place in the forms of the isothermal lines. They should approach the coast at the parts screened by the mountains, while they should remain stationary, or sometimes recede towards the interior, at the intervals between the mountains. If the interior of the island does not consist entirely of dry plains, but is covered with lakes and considerable areas of undrained marshy land, such evaporating surfaces will cool the surrounding air. If the evaporating surfaces be concentrated chiefly about the centre of the island, their influence will not be much felt at the coast, and thus, although they may produce some local changes in the forms of the isothermal lines in their neighborhood, their most important effect will be to render still more decisive the differences of temperature on a line drawn from the coldest region at the centre to the coast; in other words, to contract or enlarge the dimensions of some of the isothermals.

3. If the influence of the differences of latitude of the surface of the island be now considered, it can be demonstrated that its

tendency will be to transport the centres of the isothermals towards the pole, in whatever hemisphere the island may be situated, and that the isothermals at the centre shall be more affected from this cause than those at the coast. Let us suppose, for precision, the island in the northern hemisphere.

Let us at first abstract the effect of all other sources of terrestrial temperature but solar radiation, and consider the proportions of heat that may be received by two elements of the surface of the island included between two adjacent isothermal lines. It will suffice to determine the quantities for the spaces included between each of their northern and each of their southern extremities respectively. From the great distance of the sun, its rays may be supposed nearly parallel, and from the limited area we are considering, the earth's figure may be supposed perfectly spherical. By the laws of radiant heat, the amount of heat received by an element s of the surface of the earth, will be represented by*

$$\frac{s\,G\cos\varphi}{R^2}.$$

G being a coefficient, independent of the state of the earth's surface, and expressing the amount of heat that passes from the sun to a unit of surface placed perpendicularly to the direction of the sun's rays at a certain unit of distance, φ the inclination of the sun's rays to a perpendicular to the plane of the element s of the earth's surface, and R the radius of the earth's orbit. But

$$s = a^2 \cos\lambda\, d\lambda\, d\mu,$$

where a is the earth's radius, λ the latitude of the point where the element s is situated, and μ its longitude. But in the spherical angle whose sides $\frac{\pi}{2}-\delta$, $\frac{\pi}{2}-\lambda$, include the angle ψ, which subtends φ, we have

$$\cos\varphi = \sin\lambda\sin\delta + \cos\lambda\cos\delta\cos\psi,$$

where δ is the sun's declination, and ψ an angle depending on the hour of the day, being included between the meridian of the element and that of the sun. The problem now before us, being connected with the proportional quantities of sunshine received by different elements and not with the absolute amounts, we may in a first approximation consider these quantities as proportional to the amount received at noon; consequently for a limited area of the sphere the quantity of heat received in the time dt is proportional to

$$\frac{Ga^2}{R^2}\iiint \cos(\lambda-\delta)\cos\lambda\, d\lambda\, d\mu\, dt.$$

* Poisson Théorie Mathématique de la Chaleur, No. 210.

But if u represents the mean longitude of the sun, and P the parameter of the earth's orbit, we should have

$$R^2\,du=\sqrt{P}\,dt.$$

But also

$$\sin\delta=\sin i\sin u,$$

i being the inclination of the equator to the ecliptic: therefore the above expression becomes

$$\frac{a^2G}{\sqrt{P}}\left\{\iiint\cos^2\lambda\sqrt{1-\sin^2 i\sin^2 u}\,du\,d\lambda\,d\mu\right.$$
$$\left.-\iiint\sin i\sin u\sin\lambda\cos\lambda\,du\,d\lambda\,d\mu\right\}$$

The limits between which the integrations for μ and λ are to be effected, will depend on the figure of the surface under consideration. For simplicity, let it be an extremely small portion of the surface of the island included between two meridians, so close to each as to include a nearly rectangular space between their segments and those of the two isothermal lines. If m be the breadth of the rectangle, we may take μ from o to m, and λ from λ_2 to λ_1, λ_1 being the latitude of the northern extremity of whichever of the isothermals is nearest the coast, and λ_2 the latitude of the northern extremity of the other isothermal. The area under consideration will be $m(\lambda_1-\lambda_2)$: The sun's longitude u must be taken from 0 to 2π in estimating the amount of solar heat received during a year.

4. The heat received by the element $m(\lambda_1-\lambda_2)$ from the influences of causes, independent of direct solar radiation, will, as already stated, be a function of the distance of this element from the coast; it will therefore be a function of the difference of its latitude and that of the nearest point on the coast. If we make $\lambda_1+\lambda_2=2A$, and represent the latitude of the northern part of the coast nearest the element of surface by l, we shall have for H the proportion of heat received by the element during a year, the expression

$$H=f(l-A)$$

$$\frac{a^2Gm}{2\sqrt{P}}\left\{\left[\tfrac{1}{2}(\sin 2\lambda_1-\sin 2\lambda_2)+\lambda_1-\lambda_2\right]\int_0^{2\pi}\sqrt{1-\sin^2 i\sin^2 u}\,du\right.$$
$$\left.-\tfrac{1}{2}(\cos 2\lambda_2-\cos 2\lambda_1)\sin i\int_0^{2\pi}\sin u\,du\right.$$

The second of these integrals vanishes between the limits, and the first may be determined by the properties of elliptic functions for

$$\int_0^{2\pi}\sqrt{1-\sin^2 i\sin^2 u}\,du=4\int_0^{\frac{1}{2}\pi}\sqrt{1-\sin^2 i\sin^2 u}\,du$$
$$=4E(i).$$

$E(i)$ representing a complete elliptic function of the second order,* whose modulus is i. The value of i being 23° 28, $E(i)$ $=1{\cdot}50658$: consequently we may ultimately write

$$H=f(l-A)$$
$$-3{\cdot}01316\frac{a^2G}{\sqrt{P}}m\left\{\sin(\lambda_1-\lambda_2)\cos(\lambda_1+\lambda_2)+\lambda_1-\lambda_2\right\}$$

But as $\sin(\lambda_1-\lambda_2)=\lambda_1-\lambda_2$, very approximately, this may be written,

$$H=f(l-A)+C(1+\cos 2A)$$

where

$$C=3{\cdot}01316\,a^2G\frac{m(\lambda_1-\lambda_2)}{\sqrt{P}}.$$

Similarly H, the proportion of heat received by the very small and nearly equal area included between the southern extremities of the isothermals, may be written

$$H_1=f(l_1-A_1)+C_1(1+\cos 2A_1)$$

where

$$C_1=C\frac{(\lambda_3-\lambda_4)}{\lambda_1-\lambda_2},\qquad 2A_1=\lambda_3-\lambda_4$$

and $l_1=$ the latitude of the nearest point of the southern coast of the island. $f(l-A)$ and $f(A_1-l_1)$ are both positive, and both are supposed, in virtue of what has been already stated, to possess the property of varying inversely with $l-A$ and A_1-l_1 respectively; in other words, $f(l-A)$ increases when $l-A$ diminishes, and $f(A_1-l_1)$ increases when A_1-l_1 diminishes. If we divide H and H_1 by the nearly equal areas $m(\lambda_1-\lambda_2)$ and $m(\lambda_3-\lambda_4)$ respectively, the results will represent the amount of heat received by the units of surface at the northern and southern extremities of the isothermals. These quantities should be equal; hence we shall have, very approximately,

$$\cos 2A+f(l-A)=\cos 2A_1+f(A_1-l_1);$$

But as $\cos 2A<\cos 2A_1$, it follows that $f(l-A)>f(A_1-l_1)$, and, consequently, $l-A<A_1-l_1$. If the influence of solar radiation were not considered, these quantities would be equal: consequently its tendency is to transport the closed isothermal line from south to north, by making the distance of its northern extremity from the northern coast less than the distance of its southern extremity from the southern coast. The same result will affect the next adjacent isothermal, and so on in succession, so that ultimately all the isothermal lines will be transported towards the north.

As

$$C(1+\cos 2A)=2C\cos_2 A,$$

* Poisson gives 0·17798, as its logarithm from Legendre, Théorie de la Chaleur, p. 490.

the heat received at any point of the earth's surface from solar radiation alone, abstracting the influence of atmospheric absorption in different latitudes, varies in conformity with Mayer's law as the square of the cosine of the latitude.

The more the influence of latitude predominates over all other causes, the more will the positions of the isothermals be changed in the manner above indicated: it follows, therefore, that while towards the equatorial coast of an island these lines terminate on the coast, they may still continue as closed curves in the interior of the island. If the influence of differences of latitude was greatly predominant over all other climatic influences, all the isothermals may terminate on the coast.

5. The quantity of heat received by a given small area during the summer and winter half-years, between the spring and autumnal equinoxes, may be readily found by integrating with respect to u, within the limits 2π and π, and afterwards within the limits π and 0. Thus we shall have the general expression

$$\frac{a^2 Gm}{p^{\frac{1}{2}}}\left\{[\cos(\lambda_1+\lambda_2)\sin(\lambda_1-\lambda_2)+\lambda_1-\lambda_2]\,E(i)\right.$$

$$\left.\pm 2\sin i\sin(\lambda_1+\lambda_2)\sin(\lambda_1-\lambda_2)\right\} \qquad (4.)$$

the term affected by $2\sin i$ is to be taken with the positive sign for that half of the year during which the sun is at the same side of the equator as the area in question, and the negative sign for the other half of the year. If $\lambda_1-\lambda_2$ be so small that its square may be neglected, then for the small area $s=m(\lambda_1-\lambda_2)$ we shall have the amount of solar heat H_1 received during either half year expressed by the equation

$$H_1=K(E(i)\cos^2 A\pm\sin i\sin 2A),\ \text{making}\ K=\frac{2a^2Gs}{p^{\frac{1}{2}}} \qquad (5.)$$

$\sin 2A$ is always positive, as A cannot exceed 90°, it follows, therefore, that the influence of latitude on the points of the isothermals will be greater during the summer half of the year than during the winter half; and therefore, all other things remaining the same, the isochimenal lines, or lines of equal winter temperature, would be less displaced from their concentric position in an island than the isotheral lines, or lines of equal summer temperature.

From the preceding expression we can determine the latitude of the parallel which receives the greatest amount of solar heat during the summer half of the year. For on differentiating we have

$$\frac{dH}{dA}=K(\sin i\cos 2A-E(i)\sin 2A),$$

This equated to zero gives

$$\text{tang.}\, 2A = \frac{\sin i}{E(i)} \qquad (6.)$$

Also, $$\frac{d^2 H}{d A^2} = -2K \left\{ \sin i \sin 2A + E(i) \cos 2A \right\}$$

If in (6) we substitute the values of $E(i)$ and $\sin i$ respectively, we shall find $A = 7° \ 24'$ nearly, $\cos 2A$ and $\sin 2A$ will both be positive, and therefore $\frac{d^2 H}{d A^2}$ negative; the above value of tang. $2A$, gives therefore a maximum value to H, and consequently the parallel which receives the greatest amount of solar heat during the half year that the sun is at the same side of the equator, is the parallel which has the latitude 7° 24′.

6. The results of these investigations become applicable to the two great continents of the eastern and western hemispheres; for as these are both completely surrounded by water, they may be considered as two immense islands. The distance from the ocean of the greater part of their surfaces, diminishes so much the action on their general climate of the waters by which they are surrounded, that the influence of difference of latitude becomes as a general rule, predominant over all other causes, and the centres of most of their isothermal lines are transported so far towards the pole, that many of these lines circumscribe the earth's axis, or lie in surfaces which cut that axis more or less obliquely.

In the interior of a continent, an elevated table-land of limited dimensions is circumstanced nearly in the same way as an island, for its edges are surrounded with air having a mean temperature nearly uniform, and different from that lying on its surface. We may therefore expect to find, even in the interior of continents, closed isothermal lines, as well as in the interior of oceanic islands.

The disturbing action of general winds will modify the forms of the isothermal lines, according to the frequency and the temperature of these winds. The warm winds will cause the isothermals to recede from the coast towards the interior in a direction opposed to that from which they emanate; the cold winds will, on the contrary, cause the isothermals to advance towards the direction from which they blow. We may, therefore, conceive the tendency of such general winds, when warm, to be to remove the centres of the isothermals from the points whence they blow; when cold, their tendency will be to approach these centres towards the same points. If we compound these tendencies with the effect of differences of latitude, we would have the resultant direction towards which the isothermal lines should be displaced from their concentric position by the action of all these disturbing causes.

ART. XXXVI.—*On the possible Intersection of the orbits of Mars and certain of the Asteroids;* by Professor DANIEL KIRKWOOD, of the Indiana University.

THE present eccentricities of the asteroidal orbits are included between the limits 0·046085 and 0·336987. Of these, some are increasing, others diminishing. We are not aware, however, that the range of variation has, in any instance, been accurately determined. If we assume the superior limit of the eccentricity, in the case of the following members of the group, to be 0·25, (and this is less than the *present* eccentricity of Juno, Phocæa, Polyhymnia, and Atalanta,) their perihelion distances at the epochs of maximum eccentricity will be as follows:

Flora,	1·650940
Ariadne,	1·652879
Harmonia,	1·700361
Melpomene,	1·722045.

The present *aphelion* distance of Mars is 1·665725, the eccentricity of the Martial orbit is, however, increasing; the secular variation being 0·000090176. According to LeVerrier the maximum eccentricity will be 0·14224. The corresponding aphelion distance will be 1·740431; greater than the *least* perihelion distances of the asteroids above named. It is obvious therefore that if the longitudes of Mars and any one of these bodies should differ by nearly 180° when the eccentricities of both are not far from their superior limits, the orbits or at least their projections on the plane of the ecliptic, *must intersect.* When it is remembered that the variation of the eccentricity is extremely slow, that the line of apsides of the orbit of Mars completes a revolution in less than 20,000 years, aud that the inclinations of the orbits of Flora, Harmonia and Ariadne, are small, the probability of a very near approach of Mars and some of these small planets—an approach so close as to render the question of the perturbations of the latter both curious and interesting—is at once apparent. If we assume the greatest eccentricity *now* found in the group, as the superior limit of the variation of *all*, the maximum *aphelion* distance of Mars will be greater than the minimum *perihelion* distances of twenty of the small planets.

Bloomington, Ind., Feb. 11, 1859.

ART. XXXVII.—*Contributions to the History of Euphotide and Saussurite;* by T. STERRY HUNT, of the Geological Survey of Canada.

1. The name of euphotide was originally given by Haüy to a rock composed of diallage and a white compact mineral which he designated as *feldspath tenace*, (the compact feldspar of Werner, the lemanite of Delamétherie, and the jade of de Saussure senior). The well-marked contrast of colors which suggested the name of euphotide is seen in the beautiful *verde di Corsica* or *verde antico di Orezza*, and in some varieties of the rock from Mt. Rose. In these the diallage is represented by a grass-green smaragdite, and this mineral and hypersthene being regarded by Haüy as varieties of diallage, he included under the head of euphotide, the *verde di Corsica*, (for which alone d'Halloy retains the name of euphotide,) the hypersthenite or hyperite of other authors, and the granitone of the Italians. This last by an error of Von Buch, in which he has been followed by Gustav Rose, is very frequently called gabbro. The true gabbro of the Italians is however a diallagic ophiolite. (Brongniart, *Classif. des Roches*, 1827, p. 75.)

Brongniart defines euphotide to be a mixture of diallage with jade, petrosilex, or compact feldspar, and including d'Halloy's two species, euphotide and granitone, but excluding hyperite, he distinguishes as varieties, jadian and feldspathic euphotides, besides ophitic (serpentinous) and micaceous euphotides, the latter being sometimes talcose.

Coquand (*Traité des Roches*, 1857,) has followed Haüy with regard to the euphotides, while Senft (*Die Felsarten*, 1857,) places in one group, under the head of hyperite, three genera, eclogite, gabbro, and hypersthenite, in the second of which he includes rocks made up of labradorite or saussurite with diallage or smaragdite. The eclogite of Haüy is composed of diallage or smaragdite, and red garnet; it often holds disthene (cyanite) through the predominance of which it passes into disthenite (disthenfels), while hypersthenite or hyperite (hypersthenfels, G. Rose) is a mixture of saussurite or labradorite with hypersthene (d'Halloy, Senft.).

Distinctions like some of the above based upon the contained varieties of pyroxene are evidently of secondary importance, and it becomes necessary to define with more strictness the nature of the other element of the rocks in question. The jade of the Swiss Alps to which de Saussure junior, afterwards gave the name of saussurite, was described by de Saussure senior, as compact, tenacious, greenish-white in color, hard enough to scratch quartz, and having a specific gravity of 3·318—3·389.

Mohs gives 3·256 for the density of a granular saussurite from Peidmont, and 3·34 for a compact variety from the Canton of Vaud, while Naumann assigns to the mineral a density of 3·40. These authors thus agree in ascribing to saussurite a specific gravity much above that of the feldspars.

Klaproth and de Saussure junior, both analyzed specimens of the saussurite from the shores of the Lake of Geneva (lemanite, I and II) while Boulanger subsequently examined the saussurite from the euphotide of Mt. Genèvre (III), and from two localities in Corsica, the valley of Orezza (IV) and the banks of the Fiumalto (V).

	I.	II.	III.	IV.	V.
Silica,	49·00	44·00	44·6	43·6	34·0
Alumina,	24·00	30·00	30·4	32·0	24·4
Peroxyd of iron,	6·50	12·50	....	....	....
Lime,	10·50	4·00	15·5	21·0	31·8
Magnesia,	3·75	....	2·5	2·4	6·4
Soda,	5·50	6·00	7·5	....	....
Potash,	....	·25	....	1·6	....
	99·25	96·75*	100·5	100·6	96·6

The physical and chemical characters of the above specimens offered considerable differences. The saussurite II. is described by de Saussure as leek-green, subtranslucent, with an oily lustre, and a finely granular, scaly fracture; it scratched quartz and had a density of 3·261. At a high temperature it fused without loss of weight, into a glass much softer than the original mineral, and having a density of only 2·8. This saussurite, which was free from any admixture of smaragdite, was scarcely attacked by boiling sulphuric acid.—(*Journal des Mines,* vol. xix, p. 205, A. D. 1805.)

The saussurite from Mt. Genèvre (III) according to Boulanger is associated with a greenish-brown smaragdite, and is itself greenish-white and compact, not scratched by the knife, and having a density of 2·65. He describes another euphotide from the same locality as having a lamellar base, with cleavages like feldspar, sometimes chatoyant, hard, not attacked by acids, and with a density of 2·58. The analysis of this undoubted feldspar gave him, silica 66·6, alumina 18·5, lime 1·8, soda 6·0, potash 4·3 = 97·2.

The euphotide of Orezza is described by Boulanger as composed of green diallage, a blackish matter also apparently a variety of diallage, and saussurite, the whole arranged in parallel bands, giving to the mass, which is very tough, a schistose fracture. The saussurite (IV) was very compact, less hard than III, and had a density of 3·18. It was easily fusible and not attacked by concentrated sulphuric acid.

* Besides 0·05 oxyd of manganese.

The euphotide of the Fiumalto consisted of green diallage with curved lamellæ in a white paste, which was tender, easily cut with a knife, and had a density of 3·30 (v). It was readily fusible and easily attacked by sulphuric acid, with which the analysis was made; the separated silica being dissolved by a solution of potash which left a residue, supposed to be diallage, and equal to 3·8 parts, which added to the above analysis makes the sum 100·4; alkalies were absent.—(*Ann. des Mines*, [3], viii, p. 159.)

Notwithstanding the peculiarities presented by saussurite, modern mineralogists have generally referred it to labradorite or some other feldspar, (see Beudant, Bischoff, Dana, Delesse, etc.). Jameson, separates it from the feldspars on account of its greater specific gravity, but recent authors seem to have entirely lost sight of this characteristic. Coquand describes saussurite as having a density of 2·87, while according to Delesse it is seldom inferior to 2·80. These authors agree in declaring the mineral to be decomposable by acids like labradorite, while Bischoff and Senft, without alluding to its density, assert that saussurite is not attacked by acids.

An analysis of saussurite by Stromeyer gives the composition of labradorite, while Lory on the other hand has described as euphotide a rock from Levaldens in the Dauphinese Alps, which is made up of an olive hornblende and a white mineral having the cleavage of a feldspar and the composition of andesine. —(*Bull. Soc. Geol. de France*, [2], vii, 540.)

Delesse examined the white base of a euphotide from Odern in the Vosges, and another from Mt. Genèvre. Both of these were highly crystalline and exhibited the polysynthetic macles of the feldspars of the triclinic system. When pulverized and treated with muriatic and sulphuric acids they swelled up and were decomposed. Delesse has however described them as saussurite. That from Odern gave him, silica 55·23, alumina 24·24, lime 6·86, magnesia 1·48, protoxyd of iron 1·11, soda 4·83, potash 3·03, water and volatile matters 3·05 = 99·83. The euphotide of Mt. Genèvre contained diallage, a serpentine-like substance, and a ferriferous carbonate of lime, besides the feldspar, whose crystalline laminæ were more than one-third of an inch in length, and gave by analysis, silica 49·78, alumina 29·65, lime 11·18, magnesia 0·56, protoxyd of iron 0·85, soda 4·04, potash 0·24, water and volatile matters 3·75 = 100·00. Of the volatile portion according to Delesse, at least 2·50 p. c. is water, the remainder being carbonic acid. (*Ann. des Mines*, [4], xvi, pp. 238 and 267.) This feldspar resembles that of the orbicular diorite of Corsica which gave to Delesse, silica 48·62, lime 12·02, alkalies 3·61, and 0·49 of water.

Under the name of saussurite von Rath has described a mineral which with hornblende (uralite) forms the greenstone of Neurode in Silesia. It had the hardness, cleavage, and crystalline structure of labradorite, but with a specific gravity of 2·99, and gave by analysis, silica 50·84, alumina 26·00, peroxyd of iron 2·73, lime 14·95, magnesia 0·22, potash 0·61, soda 4·68, volatile 1·21 = 101·24.—(*Pogg. Ann.*, xcv, 555.)

2. Accepting the view maintained by Rose, Bischoff and Delesse, that saussurite is nothing more than a feldspar, I referred to this species the compact feldspars of the Laurentian rocks of Canada, described in my report of 1854. Associated with the limestones and ophiolites of this most ancient geological series, is a great body of crystalline stratified rocks, composed essentially of anorthic feldspars, sometimes almost without admixture, but frequently associated with green granular or cleavable pyroxene, which passes through a kind of bronzite into hypersthene. Small quantities of epidote, garnet, and more rarely mica and quartz, are also met with, and magnetite and ilmenite are common. Different varieties of these rocks would be referred by lithologists to the species labradophyre, dolerite, and euphotide. The feldspars are sometimes very coarsely crystalline but often compact; they have a hardness of 6·0, and vary in density from 2·67 to 2·73, and in composition from andesine to vosgite. The denser varieties are those in which lime and alumina predominate; all of them contain besides soda small quantities of potash. The analyses of numerous varieties of these feldspars will be found in the Report cited above, and in the *L. E. and D. Philos. Magazine*, [4], ix, 262.

The euphotides examined by Delesse and Lory are apparently nothing more than varieties of dolerite, by which term we understand a rock composed essentially of a triclinic feldspar, with some variety of pyroxene, which may be augite, hypersthene, or diallage. According to G. Rose, smaragdite, which is the variety of pyroxene regarded as characteristic of euphotide, has often the external form of pyroxene with the cleavage of hornblende, constituting the variety uralite, while in the euphotides of Baste and Veltlin hornblende occurs with the diallage, and sometimes replaces it entirely, giving rise to a rock composed of saussurite and hornblende. Sandberger has observed crystals of pyroxene forming macles with others of hornblende, and the latter often surround the crystals of pyroxene, or as I have remarked in specimens from Madawaska, small crystals of deep green hornblende are implanted upon large prisms of greenish-white pyroxene. Smaragdite according to Hisinger and Delafosse consists of laminæ of pyroxene and hornblende united in a more or less regular manner. Since diorite is distinguished from dolerite by the substitution of hornblende for pyroxene, it

is evident that feldspathic aggregates like those of Baste present a transition from the one to the other species of rock.

Diorite is distinguished from diabase according to Senft by containing a feldspar insoluble in acids (albite or oligoclase,) and by the frequent presence of quartz, while in diabase the feldspathic element is less silicious and decomposable by acids; (labradorite or a variety approaching anorthite).* When however we consider the manner in which these feldspars pass into one another, this distinction between diorite and diabase seems of but secondary importance. We have seen that the orbicular diorite (or diabase) of Corsica contains a feldspar near anorthite in composition, while others in the Vosges, according to Delesse, contain labradorite and andesine, the latter with quartz. Lory has described a diorite from the crystalline schists of the mountains of Chalanches (Isère) which is made up of a chromiferous hornblende, with crystalline andesine and a pale greenish-yellow epidote often intimately mixed with the feldspar, and so abundant as to characterize the rock. This epidote gave by analysis, silica 40·6, alumina 30·2, lime 17·7, protoxyd of iron 11·2 = 99·7.

3. Diorites, as already mentioned, sometimes contain albite. Associated with the Silurian ophiolites of Canada we often find beds of rock which are mixtures of albite with hornblende or pyroxene, sometimes with small portions of carbonates. These diorites are tough, granular, sub-translucent, greenish or bluish-gray in color, weathering superficially to an opaque white and having a somewhat waxy lustre. Hardness 6·0; density 2·71—2·76. The hornblendic element is sometimes nearly amorphous, but at other times forms cleavable grains; by ignition these portions become darker, while the feldspar is rendered whiter and more opaque, and often exhibits striæ upon the cleavage surfaces.

A fine grained variety of this diorite from Orford was examined; it had a somewhat yellowish-green color and a subconchoidal fracture. After ignition the striated crystalline grains of feldspar were distinctly seen. The powdered rock does not effervesce with nitric acid, which appears to be without action upon it. The analysis gave as follows:

				Oxygen.
Silica,	63·60	63·40		33·81
Alumina,		12·70		5·93
Soda,		7·95		2·07
Potash,		·13		
Lime,	7·28	7·50	2·14	4·43
Magnesia,		3·37	1·35	
Protoxyd of iron,		4·23	·94	
Loss by ignition,		·40		
		99·68		

* See R. H. Scott, *L. E. and D. Phil. Mag.*, [4], xv, 518.

The oxygen ratios of the alkalies and alumina in the above analysis are very nearly as 1 : 3, and if to these we add the silica corresponding to twelve equivalents, or in round numbers to 24·00 of oxygen (equal to 45·00 of silica) we shall have 65·78 parts of albite, in which the oxygen ratios are 1 : 3 : 12. The oxygen of the remaining silica and protoxyds equal 9·81 : 4·43, showing a slight excess of silica over the proportion required to form a pyroxene.*

The feldspathic base of dioritic and doleritic rocks is sometimes even more silicious than albite, and passes into petrosilex, which may be regarded as a mixture of feldspar with quartz, or perhaps a distinct feldspar like krablite. Brongniart mentions petrosilex as sometimes forming the base of euphotide, and Thompson has described under the name of saussurite a mineral which occurs with diallage at the Lizard in Cornwall, having a density of 2·80, and yielding by analysis 82·0 p. c. of silica, besides alumina, lime, magnesia and oxyd of iron. In this connection I may cite from my report above referred to, the analyses of two varieties of petrosilex. The first (A) forms great beds among the ophiolite rocks of Orford; it is apparently homogeneous, somewhat translucent, very tough and with a scaly conchoidal fracture; it is distinguished from the diorites just described by the absence of the white opaque coating upon the weathered surfaces. Color greenish or grayish-white; lustre waxy, dull. Hardness 6·0; density 2·635—2·639. The second (B) from St. Henri, is a finely granular greenish rock, which occurs interstratified with shales and limestones in unaltered Silurian strata which are regarded as the equivalents of the ophiolitic series. It is somewhat less compact and tenacious than the last, which however, it closely resembles.

	A.	B.
Silica,	78·40	71·40
Alumina,	11·81	13·60
Soda,	4·42	3·31
Potash,	1·93	2·37
Lime,	·84	·84
Magnesia,	·77	2·40
Protoxyd of iron,	·72	3·24
Loss by ignition,	·90	2·50
	99·79	99·66

4. While engaged in the examination of the various feldspathic rocks which are associated with the ophiolites of Canada, I was constantly looking for some mineral whose hardness and specific gravity should correspond to those of the jade or saussurite of

* See for further analyses the Report of Geol. Survey of Canada for 1856, p. 453, in which the above analysis is calculated for the old equivalent weights of silica. In the present paper the equivalent of $Si\,O_2$, has been reckoned at 14+16 =30.

de Saussure and Mohs. At length I met with a very heavy rock which occurs with the ophiolites of Orford, and closely resembles an ophitic euphotide. It is made up of a white garnet having the aspect of saussurite, intermingled with a small amount of a soft green serpentine, which fills the interstices between irregular rounded masses of the garnet; portions of the latter mineral half an inch in diameter, are easily obtained in a state of purity. It is distinguished by a hardness of 7·0, and by its density, which for selected fragments, was found to be 3·522—3·536. It is amorphous, finely granular, and extremely tenacious, with a conchoidal fracture; lustre feeble, waxy; color yellowish or greenish-white; sub-translucent. After intense ignition, which did not however effect its fusion, the pulverized mineral gelatinized with hydrochloric acid. Its analysis was made after fusion with carbonate of soda, and gave:—

Silica,	38·60	38·80
Alumina,	22·71	
Lime,	34·83	
Magnesia,	·49	
Oxyds of iron and manganese,	1·60	
Soda and a trace of potash,	·47	
Loss by ignition,	1·10	
	99·80	

This mineral agrees closely in composition and properties with lime-alumina garnet, whose theoretical composition is represented by silica 40·1, alumina 22·7, lime 37·2 = 100·0. Croft obtained for a white garnet from the Ural mountains, having a density of 3·504: silica 36·86, alumina 24·90, lime 37·15 = 98·10.

At the falls of the river Guillaume in St. François, (Beauce,) there is also found a heavy rock which is composed in great part of garnet. It forms a bed in contact with an ophiolite, and has a somewhat variable aspect; in some portions it has a sub-conchoidal fracture with traces of crystallization; lustre shining, somewhat silky, color yellowish-white, sub-translucent. This variety, which is apparently homogeneous and exceedingly tough, has a hardness of 7·0, and scratches deeply the surface of agate; its specific gravity was found to be 3·333—3·364. It also occurs as a greenish-white or grayish-white somewhat granular rock, cavities in which are lined with small indistinct crystals; the density of this variety was 3·397—3·436.

Other specimens from the same locality exhibit the garnet intermingled with large cleavable masses of dark-green hornblende, which passes into a pearl-grey or lavender-grey variety. Small fragments of the garnet from this mixture had a density of 3·496; they were white, opaque, with a conchoidal fracture, and somewhat vitreous lustre. Intermingled with the garnet and hornblende, was another white or yellowish-white amorphous mineral, with a waxy lustre and a hardness of 6·0; the density

of a nearly pure specimen of it was 2·729, of another fragment 2·823. This, conjoined with its hardness, renders it probable that it is a feldspar; but it is very difficult to separate it from the garnet, or even to distinguish between the two species by the eye alone. Another specimen of a white granular rock from the same locality, which had been taken for garnet, had a density of only 2·800, and was supposed to be chiefly feldspathic in its nature. The specific gravity of the greyish hornblende was 3·046.

A specimen of the first described variety, having a density of 3·333 was selected for analysis; its powder did not effervesce with heated nitric acid, which however dissolved from it considerable alumina and lime. By the ignition of the rock, its yellowish color was only changed by the appearance of rare points of blackish-green. The analysis gave as follows:—

		Oxygen.
Silica,	44·85	23·69
Alumina,	10·76	5·03
Peroxyd of iron,	3·20	·96
Lime,	34·38	9·77
Magnesia,	5·24	2·09
Loss by ignition,	1·10	
	99·53	

If we suppose the alumina the peroxyd of iron and a portion of lime to form a garnet in which the oxygen ratios of the protoxyds, sesquioxyds and silica are 1 : 1 : 2, the residual lime and silica with the magnesia will be in the proportions requisite to form a pyroxene. We have lime 21·07, alumina 10·76, peroxyd of iron, 3·20, silica 22·69=57·72, with the oxygen content 5·99 : 5·99 : 11·98. There remains then for the pyroxene, lime 13·31, magnesia 5·24, silica 22·16=40·71, containing oxygen 5·87 and 11·71=1 : 2. The observed density of the rock corresponds very closely with that calculated for a mixture of lime-alumina garnet and pyroxene in the above proportions.—(*Geol. Survey of Canada*, Report, 1856, p. 449).

5. The great density of the above described garnet rocks and their association with hornblende, serpentine and feldspar, led me to suppose that similar rocks might have furnished to different chemists some of the discordant facts which are met with in the history of euphotide and saussurite. I have recently, however, through the kindness of Prof. Arnold Guyot, now of Princeton, New Jersey, had an opportunity of examining a collection of the euphotides of Switzerland, made by him in the course of his researches on the distribution of the erratic rocks of the basin of the Rhone. Prof. Guyot then traced the euphotides, which are found in scattered blocks and pebbles for a distance of nearly one hundred and fifty miles, to the valley of Sass, or rather to the corresponding chain of the Sassgrat, which forms a part of

Mt. Rose.* The euphotides of the Alps according to other observers are associated with protogine, ophiolites and crystalline schists.

I had now before me the original euphotides which had been studied by Haüy and de Saussure, and through the liberality of Prof. Guyot was furnished with numerous specimens of the characteristic varieties. Their examination has afforded me the following mineral species: saussurite, smaragdite, actinolite, talc, feldspar, and rarely pyrites.

The saussurite, which is generally predominant, is very uniform in its characters; it is always finely granular or compact, very tough, and with a sub-conchoidal or splintery fracture. Its color is white, passing into greenish bluish and yellowish-white, rarely with flesh-red stains; sub-translucent; lustre feeble, waxy. Hardness 7·0; scratches quartz. Specific gravity 3·33—3·38. A euphotide containing cleavable masses of smaragdite an inch in diameter, afforded me portions of bluish-white saussurite, apparently homogeneous, and having a density of 3·336—3·365. Another specimen of euphotide, containing a good deal of talc, and only small grains of smaragdite, had a density in the mass of 3·315, but selected fragments of the saussurite gave the number 3·385. Another large fragment of greenish-white saussurite had a specific gravity of 3·338, while a fourth specimen of euphotide holding only small lamellæ of smaragdite, and mingled with greenish-gray talc, had a distinctly granular texture, and a density of only 3·16—3·20.

The smaragdite of all these varieties of euphotide has a grass green color passing into emerald and olive-green. Lustre somewhat pearly; hardness 5·5; specific gravity of fragments from the first-mentioned euphotide, 3·10—3·12. The smaragdite generally exhibits only the cleavages of pyroxene, but in some cases it is irregularly penetrated by slender prisms of hornblende.

Talc is rarely absent from these euphotides, and is often abundant in small foliated or radiated masses, enclosed in the saussurite. The talc is generally silver-white, but occasionally appears greenish from the presence of minute crystals of dark green actinolite, which may be seen penetrating the talc, in close proximity to the yellowish-green smaragdite. The latter I have always found enclosed in the saussurite.

A bluish-gray or lilac feldspar is often met with in these euphotides, and is at once distinguished from the saussurite by its color, cleavage, translucency, vitreous lustre, and inferior hardness. I have not observed cleavage faces of this feldspar more than a fourth of an inch in length, although in some specimens it is rather abundant. Grains of it are sometimes imbedded in the talc, but it more generally occurs in the saussurite.

* See also Jas. Forbes, *Travels through the Alps*, p. 352.

This feldspar is completely decomposed by heated sulphuric acid, and contains a large proportion of lime, characters which show it to be labradorite or an allied variety.

Two specimens of saussurite were selected for analysis, the bluish-white variety from the first mentioned euphotide having a specific gravity of 3·365, (VI) and selected fragments of a greenish-white variety from the second, with a density of 3·385, (VII). This was penetrated by talc, from which it was impossible, completely to separate it. The eleutriated mineral was decomposed by prolonged fusion with carbonate of soda, the separated silica and alumina being in each case carefully analyzed. The alkalies were determined by J. Lawrence Smith's method of igniting with carbonate of lime and sal-ammoniac, and consisted of soda with but traces of potash. The results were as follows:

	VI.	Oxygen.	VII.	Oxygen.
Silica,	43·59	23·25	48·10	25·65
Alumina,	27·72	13·95	25·34	11·94
Peroxyd of iron,	2·61	·78	3·30	·99
Lime,	19·71	5·63	12·60	3·60
Magnesia,	2·98	1·19	6·76	2·70
Soda,	3·08	·80	3·55	·91
Loss by ignition,	·35	....	·66	....
	100·04		100·31	

Boiling concentrated sulphuric acid removed only traces of alumina and lime from the pulverized saussurite, which was however partially decomposed by this acid after having been strongly ignited.

The hardness and specific gravity of saussurite assign it a place with epidote. Rammelsberg has recently published the analyses of six varieties of lime-alumina epidote or zoisite, varying in density from 3·25 to 3·36, and finds the oxygen ratios of the protoxyds, peroxyds and silica to be nearly as 1 : 2 : 3, often however with an excess of silica. The ratios of his analyses vary between the limits 1 : 1·94—2·16 : 2·95—3·36.—(*Berlin Acad. Ber.* 1856, 605).

If we follow Rammelsberg, who has regarded the small amount of iron in the zoisites, as peroxyd replacing alumina, we have for the analysis VI the ratios 7·62 : 14·73 : 23·25=1 : 1·93 : 3·05, while for VII we have 7·21 : 12·93 : 25·65, showing an excess both of silica and protoxyd, due to the intermingled talc. If we regard this surplus of protoxyd as magnesia it would equal 5·70 per cent of talc, and deducting the elements of this from the analysis, we have for the oxygen ratios of the saussurite the numbers 1 : 2 : 3·29. Saussurite has then the hardness, specific gravity and chemical composition of a lime-alumina epidote or zoisite, containing small portions of magnesia and soda, which are frequently present in this species. The analyses of

various epidotes give from two to six per cent of magnesia, and from one to more than two per cent of soda.*—(See *Dana's Mineralogy*, 4th Ed., ii, 407).

6. The composition of zoisite as already noticed by Rammelsberg is identical with that of meionite, a species which is shown by its hardness of 6·0 and its density of 2·6—2·7, to belong to the dimetric division of the feldspar group, where it is to the scapolites what anorthite (with the ratios 1 : 3 : 4,) is to the triclinic feldspars. The mineral described by Boulanger as saussurite from Mt. Genèvre, with a density of 2·65, gives according to his analysis (III) the oxygen ratios 7·37 : 14·18 : 23·75=1 : 1·91 : 2·22, and appears to have been meionite. In de Saussure's analysis, (II) if we regard the iron as protoxyd, we obtain the ratios 5·22 : 14·02 : 23·50, but there is then a deficiency of 4·50 p. c. in the analysis of an anhydrous mineral. Klaproth's results (I) seem to indicate a mixture of a silicate like pyroxene or talc as in VII, while the anomalous softness of V and the facility with which it is decomposed by acids, render it difficult to form any conclusion about the saussurite of the Fiumalto examined by Boulanger. His analysis of the saussurite of Orezza (IV) gives the oxygen ratios 7·23 : 14·95 : 23·25=1 : 2·06 : 3·21, so that it has the composition of meionite and zoisite, while its specific gravity is between the two. Although inferior in hardness, it resembles zoisite in resisting according to Boulanger the action of concentrated sulphuric acid.

The saussurite of Orezza evidently demands farther study; it remains to be seen whether the *verde di Corsica* or *verde antico di Orezza*, as it is also named, (the corsilite of Pinkerton, *Petralogy*, ii, 78), which is regarded by d'Halloy as the typical euphotide, is not distinct from that of Mt. Rose. Delesse found the specific gravity of the Corsican euphotide to be only 3·10. The name

* Laurent in an essay on the silicates published in 1849, insisted that distinctions based on the relations between the proportions of protoxyds and sesquioxyds are of but secondary importance, since these oxyds may replace each other to an indefinite extent in many silicates, without altering the mineral type. This principle Laurent then illustrated by the epidotes among other species, showing from Hermann's analyses of thirteen specimens (of which the analyst had made three sub-species,) that although the oxygen ratios of the protoxyds and sesquioxyds offered considerable variations, it was possible by admitting the substitution of the one for the other, to reduce all these epidotes to the same formula with garnet, SiO_2R_2, *i. e.*, $SiO+RO$, in which RO, represents both protoxyds like CaO, and sesquioxyds like $alO (=Al_2O_3 \div 3)$.—(*Comptes Rendus der Travaux de Chemie*, 1849, p. 277).

This idea of Laurent although at the time rejected, is now universally admitted Dana has adopted it in the 4th Ed. of his Mineralogy; Hermann has recently reviewed his own analyses and accepts Laurent's view, while Rammelsberg who illustrated it in his laborious researches on the tourmalines, has recently applied it to the augites and hornblendes containing peroxyd of iron. But while there is no doubt of the general and wide application of this principle of the homœmorphism of protoxyds with sesquioxyds, it is nevertheless true as Dana has remarked, that in the epidotes the variations in the oxygen ratios of the protoxyds, sesquioxyds and silica are about 1 : 2 : 3, which may be looked upon as the normal ratio for epidote, as 1 : 1 : 2 is for garnet, and 3 : 2 : 5, for idocrase.—(This Jour., [2,] xxv, 406).

of *verde di Corsica*, which in the arts is applied to the rock as a whole, is by Beudant restricted to the contained smaragdite.

I have lately examined a pale yellowish-green compact and apparently homogeneous rock, which forms great beds among the crystalline schists of the Shickshock mountains in Gaspé, and has somewhat the aspect of saussurite. Its hardness is 7·0 and its density 3·04—3·09. It is exceedingly tough and sonorous, has a conchoidal fracture with a feeble waxy lustre, and is translucent on the edges. The analysis gave as follows:

		Oxygen.
Silica	62·60	33·38
Alumina,	12·30	5·78
Protoxyd of iron,	9·40	2·82
Lime,	14·10	4·03
Magnesia,	·72	·29
Soda with a trace of potash,	·43	·11
Loss on ignition,	·16	
	99·71	

The oxygen of the protoxyds and peroxyds in the above analysis equals 4·43 and 8·60. If to these we add the silica corresponding to 13·00 of oxygen, we shall have 61·33 parts of epidote, leaving 32·22 parts of silica uncombined. The density of the mass is that of a mixture of epidote and quartz in the above proportions, and in some specimens where the rock becomes granular, the two species are easily distinguishable. (*Geol. Survey of Canada, Report*, 1858). This epidote rock then is completely distinct from the saussurite of Orezza.

The two silicates zoisite and meionite offer a remarkable instance of that isomerism in mineral species upon whose importance I have long insisted. The relation of the specific gravity to the empirical equivalent weights of minerals, must enter as an essential element into a classification which shall unite the chemical and natural-historical systems. Similar isomeric relations exist between kyanite and sillimanite, rutile and anatase, and as I have elsewhere endeavored to show, among the carbon-spars. It becomes necessary in the study of mineral species to determine their relative equivalent weights, to which specific gravity must be the chief guide.—(*Proc. Am. Assoc. Adv. Science,* 1854, pp. 240–247).*

* The action of heat upon organic bodies of high equivalent tends to resolve them into simpler and less dense forms, (we except of course the simultaneous productions of small portions of more complex hydrocarbons). Similar results are obtained when the denser silicates are fused. Thus according to Magnus the specific gravity of garnet is lessened one-fifth by fusion, while that of idocrase is reduced from 3·84 to 2·94. Epidote by ignition has its density changed from 3·40 to 3·20 according to Rammelsberg, and saussurite is converted by fusion into a soft glass of specific gravity 2·8. The silicates thus modified are decomposable by acids like the basic feldspars; idocrase and garnet crystallize after fusion, the latter according to von Kobell in octahedrons. Deville found the density of hornblende and pyroxene to be reduced by fusion from 3·2 to 2·8, orthoclase from 2·56 to 2·35, and labradorite from 2·689 to 2·525.

7. *Smaragdite.*—The smaragdite or diallage of the euphotides appears to have been first examined by Vauquelin, who found in a specimen from Corsica with specific gravity 3·0; silica 50·0, alumina 21·0, lime 13·0, magnesia 6·0, oxyd of iron 5·5, oxyd of chromium 7·5, oxyd of copper 1·5=104·5. (Beudant, *Mineralogie*, ii, p. 134). Boulanger subsequently analyzed the diallage from the euphotide of the Fiumalto already described. It had a density of 3·10, and gave silica 40·8, alumina 12·6, lime 23·0, magnesia 11·2, protoxyd of iron 3·2, protoxyd of manganese 1·4, oxyd of chromium 2·0, water 5·2=99·4.—(*Ann. des Mines*, [3], viii, 159).

I have analyzed the grass-green smaragdite already described as occurring in masses an inch in diameter imbedded in the saussurite VI. It was to some extent penetrated by the latter mineral, and contained irregularly disseminated slender prisms of hornblende, apparently associated with talc. The analysis gave as follows:

Silica,	54·30
Alumina,	4·54
Lime,	13·72
Magnesia,	19·01
Protoxyd of iron,	3·87
Oxyd of chromium,	·61
Oxyd of nickel,	*traces*
Soda,	2·80
Loss by ignition,	·30
	99·15

A partial analysis of another specimen gave alumina 3·80, lime 14·22, magnesia 18·07, protoxyd of iron 2·34. The pale green color of the powdered smaragdite becomes brownish on ignition. The small portion of nickel, whose presence I have already shown in a great number of chromiferous serpentines and diallages,* gave evidence of a trace of cobalt before the blowpipe. The oxygen ratios of the silica, alumina and protoxyds in the above analysis are as 28·96 : 2·12 : 13·29. Its composition is evidently that of a pyroxene, with some admixture of saussurite and probably of talc. A portion of the latter mineral from one of the euphotides of Mt. Rose, was submitted to analysis, and allowing for a small admixture of saussurite, was found to have the composition of ordinary talc, being a hydrated silicate of magnesia with a little iron and a trace of nickel.

Conclusions.—1. The true euphotide is distinct from the diallagic dolerites, with which most modern lithologists have confounded it, and which are composed of pyroxene and a feldspar having the constitution of andesine, labradorite, or a still more basic variety approaching to anorthite. By the substitution of hornblende for pyroxene these dolerites pass into diorite or diabase.

* This Journal, [2,] xxvi, 237.

2. The euphotides of Mt. Rose according to my observations are composed of smaragdite (a pyroxene containing chrome and nickel,) in a base of saussurite, which is a compact zoisite, or lime-alumina epidote, containing portions of magnesia and soda, and having a hardness of 7·0 and a specific gravity of 3·33—3·38; characters which at once distinguish it from the feldspars. These euphotides also contain as accidental minerals, talc, actinolite and occasionally a vitreous cleavable feldspar resembling labradorite.

3. While the minerals analyzed as saussurite by Stromeyer and Delesse are feldspars, that from Mt. Genèvre examined by Boulanger has the composition and specific gravity of meionite, a species which is isomeric with zoisite; the saussurite from Orezza according to the same observer has a like composition but a density intermediate between these species. The saussurite examined by Thompson is apparently a petrosilex.

4. By its great density and its composition, the euphotide of Mt. Rose is related to certain rocks in which a white garnet, resembling saussurite, is mixed with serpentine, with hornblende, and with a feldspathic mineral. These aggregates associated with ophiolites, albitic diorites, and a rock made up of epidote and quartz, occur in the form of beds in the crystalline schists of the altered Silurian series in Canada.*

ART. XXXVIII.—*The Dynamic Theory of the Tides;* by Maj. J. G. BARNARD, A.M., Corps of Engineers, U. S. A.

IN his treatise on "Tides and Waves," Mr. Airy uses in reference to Laplace's investigation of the tides, the following language:

"If now, putting from our thoughts the details of the investigation, we consider its general plan and objects, we must allow it to be one of the most splendid works of the greatest mathematician of the past age. To appreciate this, the reader must consider, first, the boldness of the writer who, having a clear understanding of the gross imperfection of the methods of his predecessors, had also the courage deliberately to take up the problem on grounds fundamentally correct, (however it might be limited by suppositions afterwards introduced); secondly, the general difficulty of treating the motions of fluids; thirdly, the peculiar difficulty of treating the motions when the fluids cover an area which is not plane but convex; and, fourthly, the sagacity of perceiving that it was necessary to consider the earth as a revolving body, and the skill of correctly introducing this consideration. The last point alone, in our opinion, gives a greater claim for reputation, than the boasted explanation of the long inequality of Jupiter and Saturn."

* See my *Contributions to the History of Ophiolites*, this Journal, [2], vol. xxv, 217, and xxvi, 234.

The equilibrium-theory, manifestly false in treating the problem simply as one of statics, disregarding the *motions* of the fluid which must accompany the changes of its superficial form, is, at least, an *explanation* of the phenomenon, though not a true theory.

Mr. Airy remarks of it;

* * * * "it must be allowed that it is one of the most contemptible theories that was ever applied to explain a collection of important physical facts. It is entirely false in its principles, and entirely inapplicable in its results. Yet, strange as it may appear, this theory has been of very great use. It has served to show that there are forces in nature following laws which bear a not very distant relation to some of the most conspicuous phenomena of the tides; and, what is far more important, it has given an algebraic form to its own results, divided into separate parts analagous to the parts into which the tidal phenomena may be divided, admitting easily of calculation and of alteration, and thus at once suggesting the mode of separating the tidal movements, and affording numerical results of theory with which they are to be compared. The greatest mathematicians and the most laborious observers of the present age have agreed equally in rejecting the *foundation* of this theory, and comparing all their observations with its *results*. And till theories are perfect (a thing scarcely to be hoped for in any subject, and less in the tides than any other,) this is one of the most important uses of theory."

If we could indeed *grasp* the conditions of the problem—bring into our analysis the expression of the *actual form* (or even a tolerable approximation to that form) of the solid nucleus whose depressions form the ocean beds, then indeed the solution would be that which we seek, not a mere *explanation*, but a true expression for the phenomena, as they actually occur.

While we are utterly incapable of doing this—when such a mind as Laplace's is found unable to grasp the conditions of a "Dynamic Theory," it seems to me that Mr. Airy wastes epithets upon the "equilibrium theory" which, after all, I presume no physicist ever regarded as a *real theory* of the tides, but rather a mere putting into mathematical form of their obvious *immediate* cause. If, to get over the difficulties of the *true theory*, and bring the problem within the grasp of our mathematics, we are obliged to make assumptions, entirely at variance with the facts which really govern the question—which cannot even *approximate* to them—we might as well, so far as the *solution* we seek is concerned, go one step further, and suppose there is no motion at all—or that the fluid is destitute of inertia; in other words fall back upon the equilibrium theory, for the problem is no longer that which we propose, but a mere mathematical study which may yield us some curious results.

"It was found necessary, however, (Airy 'Tides and Waves,") in order to make the application of mathematics practicable, to start with two suppositions, which are inapplicable to the state of the earth. These are: that the earth is covered with water; and that the depth of this water is the same through the whole extent of any parallel of latitude."

If the *actual configuration* of the ocean's bed is, as I have before remarked, the very basis of a dynamic theory of the tides, then a theory which is obliged to reject entirely this actual configuration, and instead of ocean beds of *limited* areas, isolated from each other by dry land in those parallels where the tidal effects are greatest, substitute an imaginary ocean covering the *whole globe*, and of the *same* depth following each parallel of latitude, the problem can be only a mathematical one of more or less interest, from which nothing of any practical value, as to the *actual* phenomena of the tides, can be expected.

Such *is*, in fact, the dynamic theory of Laplace; it has furnished no result nor been of the slightest use to physicists in their investigations of the tidal phenomena. Mr. Airy remarks, "under these suppositions (the arbitrary assumptions as to the ocean's extent and depth) it is evident that the theory is far from being one of practical application;" but when we consider that, in the very effort to make the theory a dynamic one, by introducing the motions of the fluid particles, the *real motions* as governed by the actual configuration of the ocean beds are discarded and purely imaginary ones substituted, we may well hesitate in giving assent to the proposition which finishes the sentence; "though it clearly approaches much nearer to truth than the theory of equilibrium which we have already described."

In the eye of the mere *theorist* it may be so, but to one who seeks a knowledge of the tides as *they actually are*, the equilibrium theory is far more useful; and of two things neither of which possess any claims to be called true, one may be considered as true or the other.

The differential equations which determine the elevation and motion of the water, when the question is limited by these arbitrary assumptions already mentioned, are obtained with no great difficulty. In fact, the equilibrium theory gives the elevation of the water as *it would be* were the water destitute of inertia; in other words, the forces of attraction of the earth and of the disturbing bodies are alone considered, while the forces of inertia in the water itself are disregarded. We have only to introduce *these* forces to convert the equilibrium into a dynamic theory; and thus considering the effects of the fluid motions only in the forces of inertia developed, it follows from the general equations of equilibrium of fluids, that the total fluid pressure resulting will be the sum of the pressures due to the separate existence of each class of forces.

Calling p the total fluid pressure at any point, arising from the action of all the forces, p' the pressure due to the earth's attraction, were its surface undisturbed, p'' the pressure due to the attractions of the disturbing body, p''' the pressure due to the forces of inertia in the fluid, we shall have

$$p=p'+p''+p'''.$$

If we desire to have the value of p at the *undisturbed surface of the* earth, put $p'=0$ and we have $p=p''+p'''$.

If we call w the height of the fluid column due to the pressure p, and q the height due to p'', we shall have (considering the density as unity) $p=gw$, $p''=gq$, and

$$(1) \qquad gw=gq+p''',$$

in which w is the *total tidal elevation* due to the disturbing attractions, and to the inertia of the fluid, and q is the elevation due to the disturbing attractions alone; in other words, it is the height *due to the equilibrium theory.*

Confining the investigation, for simplicity, to the attractions of the *sun* alone, we shall find from the equilibrium theory (vide Airy's "Tides and Waves" par. 44,)

$$(2) \quad q=S'\left(\frac{P}{P_m}\right)^3\Big[(\tfrac{3}{2}\cos^2\sigma-1)(1-3\sin^2\lambda)+\tfrac{3}{2}\sin 2\lambda\sin 2\sigma\cos(l-s)+$$
$$+\tfrac{3}{2}\cos^2\lambda\cos^2\sigma\cos 2(l-s).$$

In which S and σ are the celestial right ascension and declination of the sun; λ and l the terrestrial latitude and longitude of the place, (the latter referred to a meridian *fixed in space*); P the actual and P_m the mean parallax of the sun and S' a coefficient which (vide par. 41 and 42) $=\dfrac{Sb^2}{2gD^3}\left(\dfrac{P_m}{P}\right)^3$ (the density of the water being considered insignificant compared to that of the earth) in which S and D are the sun's mass and distance, b the earth's polar radius,* and g the force of terrestrial gravity.

In the equation (2) the angle $(l-s)$ is the difference in *longitude* of the point of observation and the sun, referrred to a meridian *fixed in space.* If we consider the earth a revolving body and call ϖ the longitude of the point, referred to a meridian on the earth's surface, and n the velocity of rotation, then the variable longitude of the point of observation, at the end of the time t, referred to a meridian fixed in space, will be represented by $nt+\varpi$, and the angle $l-s$, by $nt+\varpi-s$.

If instead of the latitude λ we use the *polar distance* θ of the point of observation we shall have

$$\cos\lambda=\sin\theta, \text{ and } \sin 2\lambda=\sin 2\theta.$$

* The *spheroidal* form is disregarded, as the tidal *displacements* are very nearly the same whether the earth is regarded as a sphere or spheroid.

Making the substitutions in equation (2), and then substituting the value of gq in equation (1), we have

$$(3)\quad gw=\frac{Sb^2}{2D^3}(\tfrac{3}{2}\cos^3\sigma-1)(1-3\cos^2\theta)+\frac{3Sb^2}{4D^3}\sin 2\sigma.\sin 2\theta\cos(nt+\varpi-s).$$
$$+\frac{3Sb^2}{4D^3}\cos^2\sigma.\sin^2\theta.\cos 2(nt+\varpi-s)+p'''.$$

If, now, we suppose a particle of water running towards the south and call u the arc (in latitude) passed over at the end of the time t, $b\frac{du}{dt}$ will be the *actual velocity* of the particle, in this direction, and $b\frac{d^2u}{dt^2}$ its acceleration. If θ is the angular polar distance of the initial position of the particle, $b\theta$ will be the actual lineal polar distance, and $\frac{dp'''}{bd\theta}$ will be the differential coefficient of the pressure arising from a variation of θ, and by a slight and admissible extension of the fundamental equations of hydrodynamics we should have $\frac{dp'''}{bd\theta}=-b\frac{d^2u}{dt^2}$.

But if the particle has, at the same time, a component of velocity towards the east, represented by $b\sin\theta\frac{dv}{dt}$ (v being arc in longitude moved over in the time t,) its centrifugal force is increased from $\frac{n^2b^2\sin^2\theta}{b\sin\theta}$ (due to the earth's rotation *alone*,) to $\frac{\left(n+\frac{dv}{dt}\right)^2 b^2\sin^2\theta}{b\sin\theta}$, the difference between which is (omitting the term containing the square of $\frac{dv}{dt}$ since it is very small compared to n) $2nb\sin\theta\frac{dv}{dt}$, and the component of this increment, $2nb\sin\theta\cos\theta\frac{dv}{dt}$, will press the particle *towards* the equator and is to be added to the value of $\frac{dp'''}{bd\theta}$ before obtained. Adding it and multiplying by b, we have

$$(4)\quad \frac{dp'''}{d\theta}=-b^2\frac{d^2u}{dt^2}+2nb^2\sin\theta\cos\theta\frac{dv}{dt}.$$

Considering now the component of angular velocity to the east $\frac{dv}{dt}$, since the radius of the small circle of latitude in which it

moves is $b\sin\theta$, the actual lineal component of velocity would be $b\sin\theta\frac{dv}{dt}$, while the differential coefficient of the pressure (in space) will be $\frac{dp'''}{b\sin\theta d\varpi}$, and considering this motion *alone*, we should have $\frac{dp'''}{b\sin\theta d\varpi}=-b\sin\theta\frac{d^2v}{dt^2}$.

But the particle of water has at the same time a southerly component of velocity $b\frac{du}{dt}$.

It is evident that, as it is passing to a lower and larger circle of latitude, to maintain its position in longitude, the moment of its quantity of motion, with reference to the axis of the earth's rotation, will be increased.

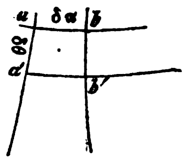
The principle that the moment of the accelerating force is equal to $\frac{d}{dt}$ (the moment of the quantity of motion) (which can be easily deduced from the equations of rotation around a fixed axis—see Bartlett Analyt. Mechanics, par. 229,) will enable us to determine the value of $\frac{dp'''}{d\varpi}$ corresponding to this cause. The accelerating force in this case (or the pressure generated by this motion of the particle) is $\frac{dp'''}{b\sin\theta d\varpi}$, and its moment with reference to the earth's axis is $\frac{dp'''}{d\varpi}$.

The moment of the quantity of motion of the particle of water (per unit of mass) due to the earth's rotation, is $nb^2\sin^2\theta$, of which the $\frac{d}{dt}$ is $2nb^2\sin\theta\cos\theta\frac{d\theta}{dt}$. But as the change in the polar distance of the particle is due to the component of velocity $\frac{du}{dt}$, $\frac{d\theta}{dt}$ will be expressed by the same, and hence, from this cause we should have $\frac{dp'''}{d\varpi}=-2nb^2\sin\theta\cos\theta\frac{du}{dt}$. (The negative sign is used since the increment of the pressure is in the reverse direction to that of ϖ).

Adding this value to that previously obtained, we have

$$(5)\qquad \frac{dp'''}{d\varpi}=-2nb^2\sin\theta\cos\theta\frac{du}{dt}-b^2\sin^2\theta\frac{d^2v}{dt^2}.$$

Another equation may be obtained from the condition of *continuity* in the fluid.



Let $aa'\,b'b$ be an elementary area of ocean surface, the angular co-ordinates of a being ϖ and θ, and ab and aa', being equal to $\delta\varpi$ and $\delta\theta$. Let the *depth* of the water at a be γ. According to the assumption with regard to the depth alluded to before, γ varies with the polar distance θ, but not with the longitude ϖ.

Let us suppose the water flowing over this area with angular components $\frac{du}{dt}$ southward and $\frac{dv}{dt}$ eastward; velocities which are themselves variable with θ and ϖ and the time. Taking a space of time t, from the origin of motion, the water will flow past the point a with a velocity which would carry it in that time through the space u, and past the point a', through the space $u+\frac{du}{d\theta}\delta\theta$.

The area of the section ab is $\gamma\delta\varpi$, and of the section $a'b'$, is $(\gamma+\frac{d\gamma}{d\theta}\delta\theta)(1+\cot\theta\delta\theta)\delta\varpi$. (Since it is easily seen that the side $a'b'$ is to ab (or $\delta\varpi$) as $\sin(\theta+\delta\theta):\sin\theta$; or as $1+\cot\theta\delta\theta:1$ (nearly). Therefore the quantity of water which flows through the section ab in the short time t, will be $u\gamma\delta\varpi$, and through the section $a'b'$ will be $(u+\frac{du}{d\theta}\delta\theta)(\gamma+\frac{d\gamma}{d\theta}\delta\theta)(1+\cot\theta\delta\theta)\delta\varpi$. The *difference* between these quantities, is the quantity of water subtracted from (or added to) the ocean area $aa'\,b'b$, and is (omitting quantities of the 3d order)

$$\frac{d}{d\theta}(u\gamma)\delta\theta\delta\varpi+u\gamma\cot\theta\delta\theta\delta\varpi.$$

The *area* of the section $aa'\,b'b$ is (nearly) $\delta\theta\delta\varpi$ (for convenience, the multiplication by the radius of the earth is omitted with all these angular quantities, as it does not affect the results) and the fall (or rise) of the tide w, due to the southern component of tidal motion, will evidently be equal to the foregoing expression divided by the area $\delta\theta\delta\varpi$.

If we now consider the eastern component of velocity $\frac{dv}{dt}$, the quantity of water which runs eastwardly through the section aa' whose area is $\gamma\delta\theta$ in the time t is $\gamma v\delta\theta$, and the quantity which flows through bb' (since both γ and $\delta\theta$ are constant in this direction) $\gamma(v+\frac{dv}{d\varpi}\delta\varpi)\delta\theta$, and the difference $\gamma\frac{dv}{d\varpi}\delta\theta\delta\varpi$, is the quantity of water subtracted from the area $aa'b'b$ through the eastern component of tidal velocity.—Adding this to the foregoing expression, and dividing by $\delta\theta\delta\varpi$ we get the actual total fall (or rise) of the tide,

$$w = -\frac{d}{d\theta}(u\gamma) - u\gamma \operatorname{cotan}\theta - \gamma\frac{dv}{d\theta} \qquad (6)$$

(The negative sign is used since w represents the elevation, positive or negative, above the undisturbed surface, and if u, and v increase with θ and ϖ, in the preceding discussion, there will be a *fall* of tide.)

Referring back now to equation (3), Mr. Airy has shown (par. 85, 86, "Tides and Waves") that each term multiplied by S may be put under the general form

$$\Theta \cos(it + k\varpi)$$

in which Θ is a function of θ alone: and also that "the equation between w, u, and v; those between p''', u and v; and that between w, p''', and the terms arising from the disturbing force, being all linear, we may take the terms arising from the disturbing force separately, and, finding the solution for each term, we may add all together. It will be sufficient, therefore, to proceed with the solution of the equation" (instead of equation (3))

$$0 = \Theta\cos(it + k\varpi) - gw + p'''$$

and combining this with equations (4), (5) and (6),

$$\frac{dp}{d\theta} = -b^2\frac{d^2u}{dt^2} + 2n\,b^2\sin\theta\cos\theta\frac{dv}{dt}$$

$$\frac{dp'''}{d\varpi} = -2n\,b^2\sin\theta\cos\theta\frac{du}{dt} - b^2\sin^2\theta\frac{d^2v}{dt^2}$$

$$w = -\frac{d}{d\theta}(u\gamma) - u\gamma\cot\theta - \gamma\frac{dv}{d\varpi},$$

we have Laplace's differential equations of tidal motions (as given by Mr. Airy).

"A general solution of these equations is scarcely to be hoped for; it is a matter of difficulty to find, in a very limited case, a particular integral which will satisfy them."—(Airy, *Tides and Waves.*") And the particular integral essayed by Laplace and Mr. Airy is of the following form:

$$w = a\cos(it + k\varpi)$$
$$u = b\cos(it + k\varpi)$$
$$v = c\sin(it + k\varpi)$$
$$p''' = a'''\cos(it + k\varpi)$$

in which a, b, c, a''' are functions of θ only.

It is not my purpose to follow the investigation any further, which is purely analytical and consists in determining for each term of equation (3), the values of these quantities, and, thence, of w, u, v, p''', by which we get the elevation, velocity, direction of motion, &c. of the tides arising from the disturbing forces expressed by the particular term.

I will only remark that the compulsory resort to this particular integral *fixes* the original assumption of an ocean covering the whole surface of the globe, irrevocably,—these values of w, u, v, and p''', being simple perturbating functions, whose perturbations in time correspond exactly with those of the forces, while they extend *in space* through the *whole* circumference of the earth, without the possibility of limitation in that direction. In short, it is the particular integral which expresses that *particular tide* belonging to an ocean *continuous in longitude.*

Excepting the arbitrary restriction applied to the variation in *depth*, the differential equations (3), (4), (5) and (6), are perfectly general, and could a general integral be obtained, a limitation of the ocean's area (approximating feebly to the continental barriers) could be established—and, thence, results which might be considered approximations to the actual phenomena. Such an integral, however, is not likely to be obtained, neither Laplace nor Mr. Airy having cared to attempt it.

"As it is, Laplace's theory fails totally in application, from the impossibility of introducing in it the consideration of the boundaries of the sea."

* * * * * * *

"If we look to the results of the theory, it will be found that they are rather of a negative than of a positive kind. They show that, without a far more complete knowledge of the form of the bottom of the sea than we can hope to possess, it will be impossible, even with more powerful mathematics, to calculate tides *à priori.* They show that the calculations founded on the equilibrium-theory cannot be good for anything. In proving that (with sea at least of a certain shallowness) the part of the equator next to the moon would be a place of *low* water, they destroy all hope of using an equilibrium-theory, even as an approximation. In establishing the remarkable result as to the non-existence of diurnal tide in height when the depth is uniform, they show that no inference can be drawn from the mere magnitude of a force as to the magnitude of its effects."—(*Airy,* "*Tides and Waves.*")

It does not seem to me that so difficult and profound a course of analysis was at all necessary to arrive at everything in these negative results at all important.

The remark in the beginning of this paper that "the *actual shape* of the ocean's bottom is the very foundation of a dynamic theory of the tides," seems almost self-evident. But our *mathematics*, thus far, has failed to grasp even the simplest approximation to *shore-outline*,—and if we had the most perfect knowledge of the form of the bottom of the sea, it would be far beyond the powers of analysis to introduce, with any accuracy, its consideration into the problem. Remarks of a similar nature might be made as to the conclusions concerning the equilibrium-theory, which, it seems to me, no philosopher could ever have regarded as *a solution.* Laplace having failed to show what the

effect of the continental barriers is, it cannot be considered as *proved*, that the equilibrium-theory is not as near an "approximation" as anything else we have or are likely to have.

My object in this paper has been to show by what simple considerations and processes the differential equations of Laplace's theory may be arrived at. In doing so I am perfectly well aware that the finding a short path to a *known result* is quite a different affair from the original discovery, and I must also remark that the *considerations* from which equations (4) and (5) are deduced are pointed out (after he has arrived at the equations by long and tedious processes) by Mr. Airy himself.

Mr. Airy concludes his able work on "Tides and Waves," by a "Theory of Waves in Canals," and which, as embracing the subject of the tides, applies to cases such as rivers and arms of the sea, to which neither the equilibrium nor dynamic theory would (if applicable elsewhere) apply,—and to "cases of open seas, where the whole may be conceived divided into parallel canals in which the circumstances are nearly similar."

The "theory" is a very beautiful one and a very valuable contribution to physical science; more valuable, I think however, for its thorough discussion of *waves* in all (or nearly all) the aspects in which they present themselves to the navigator, naval constructor, or engineer, than for its application to the tides. Though it doubtless comes much nearer an approximation to the circumstances under which the tides actually flow in rivers or arms of the sea, than the dynamic or equilibrium theories do to the tides of the ocean, yet the vast difference between the *actual* configuration of shores and beds of such canals, and the simple assumptions the theory is confined to, will probably render this, like all other theories, useless, or nearly so, in practice.

The subject of the tides of the ocean, though perhaps as intelligible as a physical phenomenon, as most others in astronomy, is in its *actual manifestations*, entirely beyond the grasp of our mathematics,—beyond any reasonable conception we can form as to the powers of the human mind to grasp, through any supposed improvement in the means of mathematical analysis. It is probable that, for the aid of the investigator, the "equilibrium theory" has done as much as any theory can be expected to do.

Art. XXXIX.—*On some Fossil Plants of Recent Formations;* by Leo Lesquereux.

The fossil plants of our recent formations have until now attracted little attention. The difficulty of identifying species of dicotyledonous plants from fragments of leaves only, is perhaps the cause of this neglect. Nevertheless the plants of the tertiary and quaternary strata will likely give a solution to some important problems in natural history. Botanists are now intently looking at the flora of those formations, not only to satisfy their minds in regard to the distribution of species of plants in the different strata, but to trace to its farthest limits the history of our present vegetation. They wish to find the origin of some genera and species now living on our earth, to trace their geographical distribution by recording their appearance and destruction at certain places and at a precise time, collecting thus, if possible, some facts that may help to unravel the causes which have changed and may still modify the march of vegetation. It is besides well known and easily understood that plants are more easily influenced by atmospherical changes than animals, at least than testaceous animals, which are those most commonly preserved in the geological strata, these only showing the changes in the sea. Even as characteristic of alluvial or fresh water formations, plants are more reliable than the remains of terrestrial animals, exposed to accidental and unaccountable migrations. The leaf of a palm tree found in the quaternary strata of Northern Russia could never have excited such discussions as did the remains of the elephant found there imbedded in the ice. We may therefore expect to obtain from botanical palæontology more precise indications about the succession of certain geological strata than from shells and animal remains only. This expectation is confirmed by the flora of the different strata of the coal-measures which is evidently different, at least as regards some of the species of plants, for each bed of coal.

Among the collections of fossil plants that have lately come under my examination, the most interesting, by far, is the one made by Dr. John Evans in his U. S. Surveying expedition of Oregon territory, Vancouver Island, &c. A description of these fossil plants appears just now to be a valuable contribution to science, and with the approval of the Secretary of the Interior, I have been advised by Dr. Evans to publish my remarks on those plants in advance of the publication of his report which will contain a full description of the fossil leaves with correct figures.

It will be interesting to mention and compare at the same time some species of fossil plants found by Prof. Jas. M. Safford in

the Pliocene of Tennessee, and some others collected by Dr. D. Dale Owen and myself in the chalk banks or Pleistocene of the Mississippi.

Species of Fossil Plants collected by Dr. John Evans at Nanaimo (Vancouver Island) and at Bellingham bay, Washington Territory.

1. *Populus rhomboidea* (Lsqx.). Leaves rhomboidal, with the margins irregularly toothed above, and entire near the slightly decurrent base. Lateral primary nerves diverging at an acute angle like the secondary ones, and ascending to both corners of the rhomb of the leaf, all strongly marked with scarcely visible percurrent veinlets. It is much like *Populus repando-crenata* of Heer, differing only by the leaves somewhat broader and by the undulations and teeth a little deeper. The *Populus mutabilis* with its numerous varieties is a characteristic plant of the upper Molasse or Miocene of Europe, especially found in the upper strata of Oeningen. (Nanaimo).

2. *Salix Islandicus* (Lsqx.). Leaves large, lanceolate, pointed, serrulate, rounded at the base. Secondary nerves in acute angles with the medial nerve, nearly straight and numerous. Subdivisions of the nerves invisible. A willow with very large leaves, apparently identical with *Salix macrophylla* (Heer) of the Miocene of Europe. (Bellingham bay.)

3. *Quercus Benzoin* (Lsqx.). Leaves shining, oval, with undulate and entire margins decurrent on the petiole. Basilar secondary nerves opposite and emerging in an acute angle above the margin and ascending to the third of the length of the leaves. Upper secondary nerves more open and diverging. The kind of nervation of this leaf is peculiar to a few species of oaks, and has also some likeness to that of the genus Benzoin. This species is distantly related to *Quercus Charpentieri* (Heer), common in the Miocene of Switzerland. (Nanaimo.)

4. *Quercus multinervis* (Lsqx.). Leaves apparently shining and oval like the former; but differing much in the numerous, deeply marked, secondary nerves all parallel, emerging in an obtuse angle from the medial nerve, and slightly arched. It is related to *Quercus neriifolia* (Braun), a species plentifully found at Oeningen. (Nanaimo.)

5. *Quercus Evansii* (Lsqx.). Leaves thick, coriaceous, half a foot long or more, elliptical, with wavy and entire margins. Primary and secondary nerves deep and broad, apparently keeled. Secondary nerves oblique, curved along the margin of the leaves. This species has the same form and nervation as *Quercus undulata*, *integrifolia*, *ovalis*, and *platyphylla* of Göppert, all species which may be referred to the same and found in abundance at Shossnitz. The size of our species is twice larger. (Bellingham bay.)

6. *Quercus Gaudini* (Lsqx.). Leaves oval-lanceolate in general outline, narrowed and somewhat decurrent at the base (sometimes rounded), sinuate, dentate above, entire below, pointed. Nerves deeply marked like the former. Apparently a very variable species, which but for the size of the leaves could be referred to the former. Among our living species, its nearest relative is *Quercus densiflora*, a species of California. (Bellingham bay.)

7. *Quercus platinervis* (Lsqx.). A very large leaf, of which fragments only were collected. It is apparently elliptical, thick, with undulate or irregularly sinuate and toothed margins. Primary and secondary nerves broad, deep, flat; secondary nerves oblique and branching above the middle; surface wrinkled by the deep tertiary and perpendicular nearly percurrent veinlets. Related to *Quercus platanoides* (Göpp.) found at Shossnitz. (Nanaimo.)

8. *Planera dubia* (Lsqx.). Leaves short oval, petioled equally serrate on the margins. Secondary nerves simple, close, running to the point of the teeth. This species is so much like *Planera Ungeri* (Braun), which characterizes the European tertiary, that it is not possible to point out a difference. It may be identical. (Bellingham bay.)

9. *Ficus?* An undeterminable species of which the broken base only is marked on the specimen. By its wavy, entire, and irregular base, and its peculiar nervation, it is referable to *Ficus populina* (Heer), of the Lower Miocene of Switzerland. (Nanaimo.)

10. *Cinnamomum Heerii* (Lsqx.). Leaves elliptical or obovate, slightly decurrent at the base on a broad petiole. Lateral nerves ascending to the top? with obsolete divisions. The genus *Cinnamomum* is largely represented in the Miocene of Europe and appears to be equally so in the tertiary strata of our northwestern continent. The species above described is nearly if not perfectly identical with *Cinnamomum Buchii* (Heer), abundant in the Molasse of Lausanne, Switzerland. (Nanaimo.)

Two fruits of the same genus were found among the specimens of Dr. Evans.

11. *Cinnamomum crassipes* (Lsqx.). Leaves very thick, cuneiform, rounded at the base, with entire margins decurrent on a broad petiole or enlarged medial nerve. Nervation acrodrome, viz., the three principal nerves ascending to the top of the leaf from the acute angle of divergence at the base. Veinlets scarcely visible. The specimens collected all show only the inferior part of the leaves, even without the petiole. But the relation of the species with *Cinnamomum Rossmæsleri* (Heer) of the Miocene of Switzerland, is evident enough. (Bellingham bay.)

12. *Persoonia oviformis* (Lsqx.). Leaves oval-coriaceous, shining or smooth; secondary nerves alternate, the basilar one ascending to above the half of the leaf. Veinlets indistinct. The part of a leaf here described might be referred to *Cinnamomum subrotundum* (Heer), a species most extensively distributed in the Miocene of Europe, but for the basilar secondary nerves which are alternate. It belongs beyond doubt to the Proteaceæ and to the genus *Persoonia*, but I do not know of any species to which it is related. (Bellingham bay.)

13. *Diospyros lancifolia* (Lsqx.). Leaves shining, oval, lanciform, taper-pointed at both ends, entire, petioled. Secondary nerves alternate, strongly marked, somewhat arched and in acute angle with the medial nerve. Veinlets obsolete. The species agrees well with *Diospyros brachysepala* (Al. Br.), common at Oeningen. (Bellingham bay.)

14. *Acer trilobatum?* (Al. Br.). Is the most abundant species of the Miocene of Europe, and I refer to it with doubt two specimens on which except the obtuse sinuses and the nervation, the outline of the leaves is not preserved. (Bellingham bay.)

With the above species I must also mention some leaves which could not be well determined for want of good specimens. A *Platanus?* with the same nervation as *Quercus platinervis;* a *Chamærops* agreeing with *Sabal Lemanonis* Brgt., common in the European Miocene, or rather a true characteristic plant of the tertiary; a very fine *Salisburia*, very variable in the outline of its leaves and named *Salisburia polymorpha* (Lsqx.), distantly related to *Salisburia adianthoides* (Ung.), found in the Pliocene of Italy; a small piece of a fern referable to the genus *Lastrea,* all these found at Nanaimo; and further a branch of *Sequoia,* apparently identical with *Sequoia sempervirens* (Endl.), still living in California. It was found on a piece of coarse sandstone at Coosa bay. A species of the same genus, viz., *Sequoia Langsdorfii* (Heer), is very abundant in the Miocene of Europe, and is so near a relative of *S. sempervirens* that M. Heer doubts if it is not the same species.

From the truly magnificent work of Prof. Heer (the Fossil Flora of the Tertiary), we see that the Shossnitz formation which was formerly referred by Prof. Göppert to the Pliocene belongs to the Upper Miocene; and that the fossiliferous strata of Heering in Tyrol and of Sotzka in Dalmatia, placed by M. Unger in the Eocene, must be admitted as Lower Miocene. Therefore, except the *Salisburia*, which would perhaps indicate a newer formation by its analogy with a species of the same genus found in the quaternary of Italy, there is not in Dr. Evans's collection a single plant that does not show a near relation to some species of the Miocene of Europe. The geological position of the coal strata of Vancouver and of Oregon where the leaves have been found is thus evident. This conclusion is not new; but it is worth remarking how closely the fossil plants characterizing the formation in Europe are analogous to those of North America.

On the coal itself, in connection with these leaves, Dr. Evans has given the following remarks already published in the National Intelligencer. "These coals do not belong to the true coal measures but to the tertiary period; they have however been altered by volcanic action. The Bellingham bay coal particularly, in consequence, is of a remarkable crystalline structure and presents under the magnifier a very singular and beautiful appearance. It will produce an excellent coke, and is well suited to manufacturing and domestic purposes. It burns freely and although rather light for long sea voyages, unless the construction of furnaces should be changed, lessening the draft, is suitable for river navigation. The coal crops out at various points from the British line to near Port Oxford in Oregon, and is accessible to sail and steam navigation, and almost inexhaustible in quantity. These coals with imperfect machines and fa-

cilities for mining can be delivered ready for shipment at from $2 to $3 per ton.

"The average analysis of many specimens gives the following results:

Fitzugh's Mine, Bellingham Bay.

Specific gravity,	1·346	
Carbon in coke,		60·23
Volatile gases,		26·85
Moisture,		10·51
Ashes,		1·94
Sulphur,		·47
		100·00

Bigelow's Mine, Dwamish R.

Specific gravity,	13·78	
Fixed carbon in coke,		54·01
Ashes,		9·00
Volatile gases,		26·33
Moisture,		10·66
		100·00

Coosa Bay.

Specific gravity,	13·84	
Carbon in coke,		59·30
Volatile gases,		25·50
Moisture,		9·50
Ashes,		5·70
		100·00

Species of Fossil Plants collected near Sommerville, Fayette Co., Tenn., by Prof. J. M. Safford, State Geologist of Tennessee.

The species of this collection that are referable to plants of our time are only four.

1. *Laurus Caroliniensis* Mchx. (Red-bay). Grows now in the swamps from South Delaware and South Virginia to the two Floridas, in pine barrens.

2. *Prunus Caroliniana* (Michx.). Wild orange tree; a species now confined to the islands and near the coasts of Carolina, Georgia, &c., and in the Bahama Islands where it is at its true latitude. Michaux remarks that this species is not found on the main land at a distance of two to ten miles from the shores where the temperature is five to six degrees colder in the winter and proportionally milder in the summer.

3. *Quercus myrtifolia* (Willd.). Inhabits now the islands south of Georgia and along the coasts of Florida.

4. Fruit of *Fragus ferruginea* (Michx.). Red beech. This fruit is somewhat more distinctly ribbed on the sides and margins than in our common species, but the characters are not distinct enough to permit a separation of species. The range of the American beech is rather northern. It is found to the south along the Alleghany mountains.

The following plants of Prof. Safford's collection are either new, viz., extinct or undescribed species, or unknown to me.

1. *Salix densinervis* (Lsqx.). Leaves narrow, one and a half to two inches long, lanceolate or tapering at both ends, entire. Medial nerve inflated at the base. Secondary nerves very close, anastomosing as in the leaves of a fern or of a *Trifolium*. The nervation is quite peculiar for a *Salix*, and perhaps when better specimens are found, the plant may be referred to another genus.

2. *Quercus! crassinervis?* (Ung.). The specimen is broken and shows only the middle part of a large, sharply dentate leaf, apparently oval-lanceolate in outline. The *broad nerves* and secondary nerves running to the point of the teeth as the form of the acute teeth also would refer this species to *Quercus crassinervis* Ung., a species found in the Upper Miocene only.

3. *Quercus Saffordii* (Lsqx.). Leaves nearly linear, less than one inch broad, five to six inches long, gradually tapering to a point. Margins regularly and distinctly mucronately serrate, entire near the base and decurrent in a broad petiole or enlarged nerve. Medial nerve broad and flat; secondary nerves oblique, straight, running to the point of the teeth and alternating with short and slender ones. There is not any published fossil species that might be compared with this. It is distantly related to living species of southern Texas and Mexico, but among the leaves kindly furnished to me for comparisom by Dr. Asa Gray, there were none of these new species to which it could be referred.

4. *Andromeda dubia* (Lsqx.). A thick, smooth, elliptical, obtusely pointed leaf, with entire, wavy, and somewhat reflexed margins and obsolete nervation. It is nearly related to *Andromeda ferruginea* (Michx.) of the pine barrens of the south. This near relation would indicate that the true identical species might be found on the islands or along the shores of the Southern States.

5. *Andromeda vaccinifoliæ affinis*. Thick, oval, lanceolate, pointed or obtuse leaves with perfectly the same size, outline and nervation as the above mentioned *A. vaccinifolia* Heer. Its nearest living relative in America is, I think, *Andromeda acuminata*. But the leaves of the fossil species are smaller and the nervation somewhat different. *A. vaccinifolia* belongs to the Upper Miocene.

6. *Elæagnus inæqualis* (Lsqx.). Leaf long, elliptical, obtuse, with entire margins, rounded near the base on one side, and about one inch longer and decurrent on the other side of the short petiole. Secondary nerves well marked, thick near their base, emerging in acute angle, with a camptodrome much divided nervation. I do not know of any living species to which this could be compared. Among the fossil plants its nearest relative is *Elæagnus acuminatus* (Web.) found at Oeningen.

Fossil Leaves collected in the chalky banks of the Mississippi River near Columbus, Ky., by Dr. D. DALE OWEN and L. LESQUEREUX.

1. *Quercus virens* (Michx.). Live oak. The leaves of this species are abundant in the strata. On this oak Michaux remarks that its range of habitat does not extend to more than ten to fifteen miles from the shores of the sea in the Southern States.

2. *Castanea nana?* (Muhl.). Our leaf is somewhat narrower than generally found in this species, which now inhabits the pine barrens of the south.

3. *Ulmus alata?* (Michx.). This species is also mentioned with some doubt. Our leaf is more pointed and its teeth shorter. It might be only a variety of *Ulmus Americana*. The only specimen is deficient.

With the above species there is another *Ulmus!* scarcely one inch long, ovate, with nervation and form of teeth of the genus, which exactly resembles *Ulmus minuta* (Göpp.) of the Upper Miocene. Perhaps it may be a variety of the following species. But it differs evidently in its simple teeth and the rounded base of the leaves.

4. *Planera Gmelini* (Michx.). This species grows now in the river swamps of Louisiana.

5. *Prinos integrifolia* (Ell.). Two leaves of this species were found in the chalk banks. They agree in every point with the *Prinos* still living in Florida.

6. *Ceanothus! Americanus?* (L.). To this very variable and common species, I refer with some doubt two leaves, one large, regularly ovate-obtuse, with somewhat decurrent margins, the other oval-lanceolate, with rounded base. The nervation and serrature of the leaves are just alike and agree with *C. americanus.*

7. *Carya olivæformis* (Nutt.). Pecan. Fruit and leaves in specimens. The geographical habitat of this species is still the same as of old.

8. *Gleditschia triacanthos* (L.). A few detached leaflets evidently belonging to the Locust.

9. *Acorus calamus* (L.). Part of a broken leaf.

10. Some undeterminable catkins of *Alnus* or *Betula*.

The remarks of Prof. D. Dale Owen in the first volume of the Survey of Kentucky, p. 22, indicates the position of the strata bearing these fossil leaves as being about 120 feet lower than the ferruginous sand in which the bones of the *Megalonyx Jeffersonii* were found. The exact position of the strata near Sommerville has not been exactly determined by Prof. Safford. But from the species of plants of his collection, they are referable to the lower or middle Pliocene.

If we now examine the general distribution of the plants enumerated above, we are at once struck with the remarkable character of the Miocenic flora of Oregon and Vancouver Island which evidently indicates a tropical climate at this period of the geological formations. Palm trees, figs, Cinnamomum, and Proteineæ are now generally distributed at least 30° lower than they were then. But it is still more extraordinary to find just on the same latitude but on an opposite point of the globe, in Switzerland, a contemporaneous fossil flora of which the species have so near a relation to those of Oregon that some of them may be regarded as truly identical. This shows a remarkable uniformity in the direction of the isothermal lines at the epoch of the Miocene formation, and establishes beyond a doubt that

the oscillations of temperature have been generally marked around our globe and have not been the result of local geological disturbances. That the oscillations were slow and progressive is shown by the distribution of the species of plants in both the following formations. In the Miocene of Vancouver the Proteineæ are dominant. It has also palm trees and Salisburia, all tropical plants, and most of the species are without relation to the plants now living on this continent. In the Pliocene of Tennessee the Proteineæ appear still abundant and the flora finds its relatives in the southern shores of Florida and on the islands of the Gulf of Mexico. The Post-pliocene of the Mississippi near the mouth of the Ohio river, and even above it, has the same species of plants as are now found along the shores of the Atlantic, in the southern states. We have thus apparently a steady decrease in the temperature from the Miocene to the Post-pliocene of the Mississippi. From this it appears to follow that the chalky banks of which the true geological position is still uncertain, ought to be regarded as anterior in origin to the Drift. For it is probable that if they had been deposited after or at the time of the ice period, the distribution of the plants would show a colder climate rather than the climate of our southern shores.

Art. XL.—*On Bornite from Dahlonega, Georgia;* by Dr. C. T. Jackson.

Bornite occurs in Field's gold mine, in Dahlonega, Georgia, in a vein of quartz, associated with native gold and some auriferous iron pyrites, in hornblende slate rocks, bordering the Chestertee River.

The mineral is found in thick foliated masses, having a crystalline structure probably hexagonal, though not perfectly defined. The masses are from half an inch to one inch in diameter, and they split like talc and mica into thin plates, quite as readily as talc.

Its lustre and color, are like those of highly polished steel. It is flexible, sectile, and soils the fingers like plumbago or molybdenite. Its streak on porcelain is metallic, or near the color of the pulverized mineral. Hardness between that of gypsum and calcareous spar, but nearer to the former, say H. = 2·25. Density 7·868. Before the blowpipe on charcoal melts, giving out white fumes, which have the odor of selenium, leaves a white deposit on the cold charcoal, and near the bead a ring of yellow color, and a little metallic bismuth is obtained.

This, cupelled, gives a little gold. In an open glass tube no smell of sulphur observed; a white smoke fills the tube, and condenses in it. Heated, this deposit forms little yellowish globules. At the lower extremity of the tube, a fused metallic mass remains adherent to the glass. A little brown sublimate is mixed with the sublimed telluric acid, and is selenium.

One gram of this mineral selected with care, to avoid all admixture of pyrites, was analyzed and the following results were obtained:

Bismuth, (BO.0·88)	0·7908
Tellurium, (metallic)	0·1800
Selenium, ($BaO+SeO^3$ 0·042)	0·0118
Gold, (mechanically mixed in fine scales)	0·0060
Loss,	0·0114
	1·0000

The bismuth was separated from the nitric solution by carbonate of ammonia, and was several times redissolved and precipitated anew, to free it from all traces of telluric acid. It was then converted by heat, in a porcelain crucible, into oxyd of bismuth. The whole of the washings and the filtrate, mixed, was evaporated to small bulk, and the nitric acid was decomposed and removed by repeated additions of chlorhydric acid and heat until no more chlorine was given off. Then the solution was brought to near neutrality by ammonia and a current of sulphurous acid gas was passed through it, until all the tellurium appeared to be reduced. It was then filtered and washed with water saturated with sulphurous acid, and the filter which had been properly tared was weighed, when dry, at 212° F.

On addition of a solution of sulphite of ammonia to the filtered solution, and allowing it to stand for forty-eight hours, more metallic tellurium subsided, and was collected in a tared filter and the amount was added to that first obtained. Standing twelve hours longer this solution gives no more deposit, though it smells strongly of sulphurous acid gas.

The selenium was determined on a separate sample, of one gram of the Bornite, by converting the selenium into selenic acid, by prolonged digestion in nitro-muriatic acid. Then the selenic acid was precipitated by nitrate of baryta, as seleniate of baryta. It weighed 0·042 gram.

By separate experiments, it was ascertained that no sulphuric acid existed in the solution of the Bornite; hence no sulphur was present.

Boston, March 12, 1859.

ART. XLI.—*Geographical Notices.* No. VII.

PHYSIOGRAPHY OF THE ISTHMUS OF CHOCÓ, NEW GRANADA. By ARTHUR SCHOTT.*—The transit line across the Isthmus of Chocó, New Granada, has been lately re-surveyed, from ocean to ocean, in the neighborhood of the seventh parallel of north latitude, by a party acting under the authority of the U. S. government. The following facts were collected in connection with the field work of the topographical party, under the immediate orders of Lieut. N. Michler, U. S. Topog. Engineers, coöperating officer of the expedition. A more general account of the results of the survey was given in this Journal, November, 1858.

The entire length of the route surveyed is about 160 miles, belonging entirely to the torrid zone, as its greatest elevation does not exceed 1000 feet above the level of the sea. By its physical features this line is divided into two distinct portions, differing from each other both in extent and in meteorological condition. The western or Pacific slope, being only 15 miles long, has an almost constantly dry climate, which appears to be peculiar to the whole extent of the Pacific coast. The eastern or Atlantic slope, 147 miles in length, situated under a sky perpetually clouded, is drenched for eight or nine months of the year by daily rain, more or less heavy. Its atmosphere at the same time is kept in a state of perpetual oscillation by never-ceasing electric changes. Along this portion of the line, the features of the country are decidedly aquatic, varying according to the hypsometrical subdivisions.

From the level of the salt water in the Gulf of Urabá to its marshy uplands and scarcely ventilated mountain forests, every kind of "lowland" is represented,—mangroves, lagoons, everglades, forest swamps and ever-shady uplands.

To facilitate a more detailed examination of the country the following synoptical table is submitted: I. Mangroves and tide-water lagoons. II. Atrato levees. III. Everglades and overflow of the Atrato. IV. The palisades. V. The lowland. VI. The tableland. VII. The Cordillera or Divide. VIII. The alluvium. IX. The mangroves. X. The beach (La Playa).

Not only is the Atlantic slope found at first sight to exceed very much in extent the western or Pacific slope (a feature which applies generally to the whole of the continent,) but also each of the topographical subdivisions mentioned is much more developed on the eastern side than on the western. Throughout almost the entire route, the aquatic character already referred to is distinctly marked in its fauna and flora. A more detailed review

* Communicated for this Journal by permission of the U. S. Navy Department.

commencing on the Atlantic shore in the Gulf of Urabá may be added to the table just given.

Section I. *Mangroves and Tidewater Lagoons.*—Among plants we find prevailing here Rhizophoreæ, aquatic Gramineæ, Polygonaceæ, Aroideæ, lacustric Palmaceæ and Musaceæ, all which by habit correspond to amphibious reptiles, to Natatores and Grallatores among the birds or to the cetaceous Manati, and to fluviatic Cavidæ like the Agouti and Lancha (Dasyprocta and Hydrochœrus). As occasional forms of animals we here find the red roaring monkey (Mycetes seniculus), and of birds two forms related to Sturnidæ, which suspend their nests from the branchtops of the mangroves, thus making them inaccessible to their enemies. To these may be added a genus of Psittacidæ in the shape of the psittaceous Macao. These birds leave their home in the more elevated regions on the eastern shore of the gulf, to follow their daily sport all over the Atrato delta, which in the evening they leave again. Nearly related, anatomically, to the Scansores are the Halcyonidæ, and we may rightfully consider them as icthyophagous climbers. They are represented by three or four distinct species, and form a characteristic type along the whole line.

This section, of an extent of about twelve English miles by way of the river, may be characterized geologically as floating alluvium, which is covered by a low but densely interwoven arboreal vegetation.

Section II. *The Atrato Levees.*—Where the surface of the country rises up to and above high-water mark, plants of more terrestrial habits are added to the former. Thus Leguminosæ with their suborders Cassieæ and Mimoseæ, also Malpighiaceæ, Malvaceæ, Euphorbiaceæ, Apocynaceæ, Margraviaceæ, Lecythidaceæ, Melastomaceæ, Bignoniaceæ, and others, are met with under a most diversified generic display. While these orders are so varied in habit, and the division of Scandentes is a prevailing type, we find a close analogy to them in the members of the fauna inhabiting this ground. Among the reptiles we observe the Iguano and the Basilisc, both of arboreal habits and only occasionally taking to the water. The Quadrumana generically increase. Mycetes Beelzebub and Pithecia leucocephala (the Zambo and the Mono cara blanca) appear with the roaring monkey. Here also the low form of Bradypus finds a safe and solitary retreat. Among the birds, the Scansores, the most appropriate form for this section of country, are represented by almost every variety. The carpophagous Psittacidæ, the entomophagous Picidæ, and the sarco- or at least oö-phagous Ramphastidæ are leading forms, together with the ichthyophagous

Halcyonidæ and the Anhinga which is a Pelicanid of arboreal habit.

Keeping step with the gradual elevation of the country the fauna and flora increase. Musaceæ and Amomaceæ, with their peculiar maximum development of chlorophyllum, may be considered as equivalents of the two herbivorous pachyderms, which seem to feed on them; they are the tapir and the peccari (Danta and Sajino of the natives). Corresponding to them is the Manati, which is said to abound through this section as it does also within the delta.

The section of the Atrato levees in its geological character is, if the expression is admissible, truly amphibious, for during eight or ten months it is thoroughly swamped by the overflow of the Atrato.

The growth of trees upon it is nevertheless very heavy, and the traveller here meets those well known mighty leguminous giants in company with mammoth forms of Bombax ceiba, and also with Cedrela, Carolinea or a Tecoma. They maintain a prominent stand upon the banks of the river or arrange themselves there in closed ranks as an impenetrable phalanx.

Here the river flows in solitary grandeur, reflecting from its mighty sheet of water an ocean of light and giving freedom to the aerial currents, which show their effects in the surpassing beauty of a tropical flora. Such is the difference, where light and air have access, that even the plague of mosquitos and the lurking effects of sickly miasms, which have their dominion within the enclosures of the swampy forests, disappear upon the openings of the river.

It is a peculiarity of the Atrato that it forms, throughout its course of nearly sixty miles from the head of its delta up to the mouth of the Sucio and still higher up, but one bed, within which it keeps collected the whole body of water, bordered by vertical banks and having an average depth of over fifty feet.

The Atrato levees are scarcely inhabitable. Even the Indians and few Zambos remain upon them only occasionally for temporary fishing and hunting. The only settlement is found at Sucio, and this is but a mere trading station for the Atrato navigators and a shipping depot for the collected raw material of caoutchouc and ivory-nuts. A few natives only remain in this place to profit by raising plantains, bananas and other fruits, Indian corn, calabassas and cacao, which latter prospers here and is of superior quality.

Section III. *The Everglades.*—In leaving the Atrato levees through the mouth of the Truandó a relapse of level is reached, which leads for about 18 or 19 miles through a region of everglades. They form on both sides of the Atrato the recipients

of the river's annual overflow. Here forest-vegetation is almost entirely checked by the eddying currents of the main river and its tributaries. Only certain swells of the bottom or levees bordering on running streams are indicated by the growth of larger trees, and so we recognize here those vegetable causeways called caños or calles by the natives, or regular hummocks in the shape of small bushy islands, which stud this vast grassy ocean.

This region is preëminently aquatic and characterized as such by its animal and vegetable forms, among which the "waders" prevail. The trees wear the same mournful adornments as the cypresses do in the dismal swamps of Louisiana or the Carolinas. Long flakes of Tillandsia usneoides are suspended from the tree-tops, playing in the wind like nature's funeral streamers. In many of the trees life seems to be extinct, and a host of parasites and pseudo-parasitic heirs have taken possession of their leafless branches and withering trunks. Here we find a variety of dendricolous Filices, Musci, Jungermanniaceæ, Hepaticæ, Lichenes, Bromeliaceæ, Aroideæ, and Orchidaceæ.

Numerically the most prominent vegetable forms are a Polygonum and a Panicum (the Gramalote and the Tabaquillo of the natives). They are frequently interspersed with a conspicuous arborescent Aroid (perhaps the poisonous Caladium arboreum) in company with which they often stand in from three to ten feet of water. The margin of such growth appears frequently lined with patches of Pontederia azurea (perhaps crassipes?) and the graceful floating Desmanthus lacustris, the Dormidera or sensitiva Nadadora of the natives. Both the latter forms are of migratory habits, and the traveller on the Atrato often meets them in the form of large floating islands, upon which little herons and the neat Parra Jacanna have their sport after insects and waterworms.

Corresponding to the dense herbaceous cover of the everglades in which millions of ichthyophagous alligators are found, is the generic and numeric display of wading birds. Among them the most prominent for its size is the herbivorous Cabrilla of the natives (Palamedea chavarilla). Scansores are also fully represented, and also some Conirostres of which the most interesting are a Crotophaga, a Cassicus (cristatus?) and a Tanagra. Of mammals only Mycetes seniculus was noticed.

The everglades are uninhabited, and from their nature will necessarily remain so.

Section IV. *The Palisades* (*Las palizadas*).—If we consider the everglades as a fresh water repetition of the tide-water lagoons below, the section of the so-called palisades may be looked at as corresponding to the Atrato levees only with this difference, that

they are not traversed by a wide running stream like the Atrato but by a multitude of minor rivers and bayous, from which air and light are more or less excluded by the over-lapping branches of the great forest covering it. Consequently we here meet a marked generical decrease of organic forms, when compared with the vegetation upon the banks of the Atrato.

The palisades thus form a belt of forest swamps, which borders the everglades to the west and covers the eastern limits of the sloping lowlands.

If we do not find here that magnificent display of individual development in organic forms which was noticed upon the Atrato levees, we still find a great increase both in species and number, when compared with the lagoons. Here forms of the most diverse nature are thrown together and flourish in closest contact. The same feature is repeated also in the animal kingdom.

Plants and animals of more terrestrial habits enliven this nocturnal region, where the sun never reaches to the bottom, and where not the slightest breeze penetrates beneath the treetops.

For this reason the higher forms of mammals are confined to but few orders, as Felidæ, Quadrumanæ, and Sciuridæ, which are naturally fit for arboreal life, and thus avoid the dark swamps below. A far greater increase was noticed among the feathery tribe, among which we find represented: Accipitres, Conirostres with a considerable variety of Buccidæ, Rasores, Columbidæ, Merulidæ, Tenuirostres, Trochilidæ, Muscicapidæ of every shape and size, Sylphiadæ and Scansores, whilst others as certain Rallidæ and Ardeidæ take leave. Of the Rail family, however, the remarkable "Psophia crepitans" seems to be still retained.

The geological character of this alluvial section is peculiar, for within its limits fallen and drifting timber forms a sort of a skeleton for the more firm though only temporary support of an otherwise incessantly shifting soil. This same timber, however, which causes such "*ground-mooring*" produces on the other hand a great number of obstructions to the navigation upon the "*subsylvatic*" branches of the Truandó river and its affluents. This characteristic of the palisades undoubtedly gave rise to the Spanish vernacular name "las palizadas," which signifies any place naturally or artificially defended by fence-work. The name is certain well chosen, for it applies as well to the hydrography as to the topography of the region.

Like Section II, the palisades are scarcely inhabitable, and only a few families of Chocóes (Indians) occasionally build here their temporary lodges, as their hunting and fishing or migrations may require. The cross extent of the palisades amounts to about 14 miles.

Section V. *The Lowland.*—Closely allied to section IV. are the lowlands with an east to west extent of about fifteen miles. The geological physiognomy of this belt differs from that of the palisades only by having a more inclined surface. The upholding strata towards the west end of the section exhibit more or less disturbed, often broken and isolated layers of tertiary rocks.

Nature's means for producing the most surprising results appear often very trifling. Here a slight increase of the angle of inclination changes almost the whole physiognomy of the surface. The Truandó, before divided into endless branches and sweeping like a many-headed Hydra through the nocturnal forests below, now gathers its waters into one bed. Its winding course is bordered by more elevated banks, which are crowned alternately by the growth of heavy timber or densely interwoven brushwork, or appear lined by patches of succulent Endogens of the orders of Musaceæ, Amomaceæ and Gramineæ, whilst the whole seems to be festooned all over with the rich garlands of a perpetual festival.

The general increase of vegetable forms through this section becomes especially marked with Filices, of which nearly all throughout the lower sections have been dendricolous. Now quite a number of forms are noticed to be terricolous within the lowlands. At the same time other orders, as Orchideæ and Aroideæ, decrease in a similar ratio as others increase.

Similar changes take place in regard to animal life. Several species of Rasores and Columbidæ appear in addition to those families observed along the Atrato banks.

Alligators seemed to be lessened in number, probably in consequence of the reduced space, occupied by water. These carnivorous Saurians seem to ascend the rivers of the country to deposit their eggs in the warm sand along the streams, thus securing their offspring above overflow, during the dry season.

The elevation of this section seems to justify somewhat, human habitations within its limits. Thus we find in its western portion one tambo? (station house of the Indians) near the mouth of the Salado, a little tributary of the Truandó. This locality is also oryctognostically marked by a fossiliferous metamorphic limestone? which in all probability will answer the purposes of a first class building stone.

Section VI. *The Table-land.*—At the western margin of the Lowland a rocky terrace rises, the steep side of which faces east. Upon the top of it the table-lands of the upper Truandó and Nercua are placed. The position of the various strata constituting these table-lands are augitic (perhaps trappean) rock, either strongly granular crystalline or compact amygdaloid or

porphyritic in texture, and schistose in structure. Layers of an argillaceous sedimentary rock of little specific gravity, stratified but bearing marks of disturbance, since their original deposition are overlying the former. In the bed of the river, erratic and drifted boulders of concretionary or semi-rock occur. Alluvium uniformly covers the whole. The lower strata are only exposed at the east end of the section and partly along the Truandó. From the mouth of the Nercua upwards only quaternary deposits are standing out.

The upheavings of the metamorphic rocks rise to a height (approximately of from 250 to 300 feet) above the waters of the Truandó; and form here a series of falls and rapids, the river rushing through the narrow pass of this formation for the distance of about three miles.

This catenary mountain range, made up of this rock, seems to be a northeasterly outrunner of the Cordillera to the west, and has received from the surveying party the name "Sierra de los Saltos;" for under the vernacular name "Saltos" this region is known to the natives.

Not only within the enclosures of the mountain pass of the Saltos, but all through the table-lands and their next vicinity below, more distinct potamographical features are perceptible. They consist of a number of real tributaries, each one draining a regular basin of its own. This is quite different from the swampy sections below, the whole extent of which is to be considered as a common estuary, where all the affluents of the Atrato and Truando lose their identity beneath the dead level of a network of lagoons and sloughs.

On the western limits of the table-land interesting signs of a volcanic axis were observed in some thermal springs, one of which was found to have a temperature of 107° F. Here the water is saline and smells like carburetted hydrogen.

On the surface of the table-lands the array of vegetable and animal forms, reaches its highest pitch of development. This undoubtedly is the result of a more thorough ventilation and insolation of the country, in addition to a better regulated drainage, and a diversified sloping of the surface. It is this section only, which a few families of Chocó Indians have taken as a permanent abode, to follow, though constantly roaming, their semi-agricultural pursuits.

Here also the plague of mosquitos and sandgnats ceases gradually; but now the traveller has to guard against the almost imperceptible aggressions of the "nigua" (Pulex penetrans).

Articulata in general appear still more diversified, especially Apidæ, Formicidæ and Cimicidæ, as also a great number of wood-destroying Coleoptera. Xylocolous and troglodytic Arachnidæ, become quite a prominent feature, while the Lepidoptera

and Neuropteræ, the beau monde among insects, display their utmost.

Reptiles also appear in full force with the exception of the alligators, which seem to prefer their sport through more aquatic regions. New forms of fish also appear, as if to exceed the superabundance of the regions below.

Aphidæ have rarely been met with, and only few were collected. The flora is also further enriched by several genera and species of palms, which did not occur below; Areca, Phytelephas, Carludovicea appear strongly represented. A still larger addition however is to be mentioned as regards ferns, which now according to their habitat may be classed as Terricolæ, Saxicolæ, Dendricolæ, and subdivided again into Insedentes, Scandentes, Ripariæ.

It will be observed that no mention has been made of the higher orders of Vertebrata being represented here, though there is no doubt that such is really the case. The scanty means of our travel generally, but especially through this and the following sections, permitted but imperfect observations on this point. One deer was observed however by the majority of the party, and so a member of the Ruminantia, (one of the most interesting orders and apparently rare throughout,) came to be noticed. As the table-lands are inhabited by hunting Indians, the representatives of higher animals, must necessarily be limited.

The line of travel through this section, amounted to about 30 miles.

Section VII. *The dividing ridge.*—The dense and unbroken forests covering this low sierra or cordillera, as some call it, are characterized by a numeric prevalence of palms and quite a selection of "Filices" not seen before. Among the latter several so-called flowering ferns appear. Otherwise a marked decline as well in generic as also in numerical development of floral forms was observed. This is probably caused by a lessened drainage. The head of the last Atlantic stream, Hingadór, is remarkable for the occurrence of several beautiful examples of an arboreous fern, (probably a Cyathea?) attaining a height of from 25 to 30 feet. A second terrestrial orchid came into notice through this section.

With animal forms the general decrease is still more perceptible, and larger animals do not seem to exist here at all, with the exception of the peccari.

A well beaten Indian path loosely connects the Indians on the Nercua with a Zambo settlement on the Pacific shore, which may also account to some degree for the general scarcity of game.

In its geological features the dividing ridge bears some analogy to the structure of the table-land. A similar trappean rock of a schistose texture, perhaps less compact, underlies a deep quaternary bed. Between both, traces of tertiary layers may be discovered by parties better fitted out for exploring purposes than we were.

In the bed of small streams on both sides, an argillaceous deposit of quite recent origin, and a calcareous conglomerate (nagelfluhe) containing coarse sand cemented together with a mortar-like matrix, were observed covering the metamorphic rock beneath. The alluvium sustaining a dense and heavy forest vegetation, made it very difficult indeed to bring out clearly the geological structure of this section.

Except in the beds of the small streams, rocks were nowhere observed. Nothing of the more solid frame of the dividing ridge was discovered except at the head of the Hingadór falls, and on the other side on the banks of the "Pie de Nercua." On the latter place, rocks in situ were seen nearly related to those on the Truandó falls.

The prevalence of terrestrial plants against aereal and arboreal forms observed through the lower portion of the Atlantic slope may justify the idea of supposing the crest of this dividing ridge to be likewise a water-shed and a meteorological divide between both oceans.

This section, though not uninhabitable, is not populated at all; it looks more like a neutral ground between the quiet Indians and the adventurous Zambos on the other side.

The distance travelled across this section is about 7·5 miles.

Section VIII. *The Alluvium.*—This section forms a narrow belt linking together the western slope of the dividing ridge and the tide-water flats below. There seems to be an increase of atmospheric humidity, which produces vegetable increase again. The generic and numeric animal and vegetable forms lost before are somewhat regained, but the region itself is of too little extent to sustain again that opulence which was observed through the corresponding sections on the Atlantic side. It is true the fauna may have been intruded upon by the population of the seaside near by.

This section also contains a number of clearings (rozas) for the cultivation of tropical field and garden fruits, which indeed is fairly commenced by the Zambos.

The width of this alluvial belt, as it was travelled over, is about three miles.

Section IX. *The Mangroves.*—This section is entirely and almost exclusively rhizophorous, much more so than its equivalent on the Atlantic side. In regard to the individual growth

of this remarkable tree, I have seen nowhere in all my travels mangle columns of such size.

One species of fern within this section descends to the tide-water mark in the same way as another species of apparently the same genus on the Atlantic. These two sea-side ferns thus may be looked at as the alpha and omega of filical growth, holding respectively both termini of the isthmus line.

The fauna rapidly decreases, clearing the scene for only a few orders and families of lower organization.

The travelling line through the mangrove belt amounted to about two miles.

Section X. *The Beach* (La playa of the natives).—This narrow peninsular neck of land is separated from the main by a narrow bay. It is a mere gain from the salt water, made by the free beat of the ocean wave, the maximum rise of which amounts to about fifteen feet.

The formation of an eastern equivalent within the Gulf of Urabá seems to be prevented there by the peculiar stowage of the waters, which hold the gulf shores in a continued state of submersion, where the tidal movements do not change over two feet.

The open beach on the Pacific forms the Peninsula of Paracuchichi, named after one of the three rivers emptying their waters into the ocean in its immediate neighborhood. In fact the seaward tendency of their currents has been the principal agency in the formation and partial detachment of this continental appendix, as we may call this peninsula.

The top of this beach above high-tide mark is crowned by a dense growth of brushwork, sparingly interspersed with single trees of larger size, and outwardly lined by a dense row of magnificent Cocos palms.

The fauna upon this outlying flat is entirely littoral and but poorly represented.

The flora is a motley growth of seashore plants and continental forms. The orders of Apocynaceæ, Bignoniaceæ, Cassicæ, Mimoseæ and Leguminosæ are general, also Passifloraceæ, Solanaceæ, Convolvulaceæ, and Gramineæ have been observed. Among the latter bunches of a graceful Uniola were very conspicuous.

The distance across the bay (bahia ensenada) and the beach is about three quarters of a mile.

Note.—In what has preceded it should be remarked that the measurements are only approximative, having been taken from rough field notes.

Georgetown, D. C., February, 1859.

Lieut. Warren's Preliminary Report of Explorations in Nebraska and Dakota.—Lieut. G. K. Warren, U. S. Topog. Engineer, has prepared and published a preliminary report dated Washington, Nov. 24, 1858, (173 pp. 8vo, Washington, 1859) of his explorations in Nebraska and Dakota. It includes a part of his observations in three expeditions; the first in 1855, when he made a reconnaissance of the Dakota country, especially of the routes between Fort Pierre and Fort Kearney, Fort Kearney and Fort Laramie, hence again to Fort Pierre, and thence to the mouth of the Big Sioux; the second in 1856, when he made a reconnaissance of the Upper Missouri, and of the Yellowstone river as far as the mouth of Powder river; the third in 1857, when under the directions of the Secretary of War, he undertook to determine the best route for continuing the military road between Mendota and the Big Sioux, westward to Fort Laramie and the South Pass, thence to proceed northward and examine the Black Hills, returning by the valley of the Niobrara and making thereof a careful examination. In the last named expedition, the most important of the three, he was accompanied by Messrs. J. H. Snowden and P. M. Engel, as topographers; Dr. F. V. Hayden as geologist; W. P. C. Carrington as meteorologist; Dr. S. Moffet as surgeon; and Lieut. James McMillan as commander of the escort, which consisted of thirty men. The report is divided as follows:

1st. Routes explored, and main incidents affecting the direction and extent.

2d. Physical geography of Nebraska, character of the soil, and resources of the country.

3d. Remarks upon the climate and meteorology.

4th. A description of the principal rivers, and discussion of the merits of different routes. And

5th. An enumeration of the Indian tribes, military posts, and routes for military operations.

It is accompanied by catalogues of the palæontological, mineralogical, botanical, and zoological specimens collected on the explorations, prepared by Dr. F. V. Hayden, so as to show the localities where they were found.

Accompanying the copy of the report which we have received, is a map (referred to in the text as in course of preparation) of all the region occupied by the Dakotas, and the best routes by which to approach and traverse it. In the preparation of this map the materials of other explorers, from those of Lewis and Clark and Long, to those of the Pacific R. R. expeditions, have been employed. It is prepared on a scale of 1 to 1,200,000, and embraces all the country from the 94th to the 106th meridian, between the 38th and 50th parallels. In its northeast corner is the Lake of the Woods, in the southeast Fort Leavenworth, in

the southwest Pike's Peak, and in the northwest the junction of Milk river with the Missouri. A number of rivers are put down on this map which have never yet been explored, except at their mouths; these are the Knife river, Heart river, Cannon Ball river, and Moreau river. But Lieut. Williamson remarks that as the expeditions under his command have gone almost around the section through which they flow, and determined with a great degree of certainty that it is an open prairie, and have gained some knowledge of their lengths and directions from the Indians, they are probably represented with a considerable degree of exactness.

We quote the following general remarks in respect to the physical geography of Nebraska.

"Leaving out of consideration for the present the smaller detached mountain masses, and beginning with the main range of the Rocky mountains, on the 49th parallel, we find their eastern base to have a direction nearly northwest and southeast, and the range crossing the Missouri at 'The Gate of the Mountains.' Continuing southeast, it crosses the Yellowstone near where Captain Clark reached that river in 1806, (latitude 46,) just south of which it forms high, snow-covered peaks. This line of mountains is broken through again by the Big Horn river, and the mountains receive the name of Big Horn mountains. The southeast terminus of the Big Horn mountains sinks into the elevated table land prairie, and the range perhaps reappears again as the Laramie mountains. (South of the latitude of Fort Laramie the line of the eastern front of the mountains is nearly north and south.)

"The Black Hills, whose geographical position we have determined, are the most eastern portion of what has heretofore been considered a part of the great mountain region west of the Mississippi; and it is worthy of note that, if a line be drawn from them to the Little Rocky mountains, on the 48th parallel, which are the most eastern portion in that latitude, this line will be parallel to the line of the main front of the mountains which I have already traced. What is still more significant is, that if a straight line be drawn from the mouth of the Yellowstone to the mouth of the Kansas river, it will also be parallel to the lines before mentioned, and will have about an equal portion of the Missouri on each side of it.

"The line of the east base of the main mountain mass is the highest, of course, of any portion of the plains, and at Raw Hide peak, near Fort Laramie, is about 5,500 feet elevation, as determined by the horizontally stratified tertiary deposits, though owing to great denudation the average height there of this line of the plains will not be so great. The same line, near the 49th parallel, has probably a somewhat less elevation. The lowest line of the plains is that along the Missouri, and its elevation, taken near Bijou Hills, (a point about on the perpendicular to it from Fort Laramie,) is about 2,130 feet, which does not differ materially from its height at the mouth of the Yellowstone. The slope of all this part of the plains (being in a direction perpendicular to the lines of equal elevation) has therefore its line of greatest descent in a northeast direction,

and north of the Niobrara; this is the direction in which a majority of the rivers flow till they join with the Missouri or Yellowstone. To the south of the Niobrara the greatest slope of the plains is to the southeast, towards the Gulf of Mexico, and this is the direction pursued there by nearly all the rivers of the plains. Thus the Niobrara would seem, as it were, to run along a swell or ridge on the surface. The average slope of the plains from the Missouri to the mountains make nowhere an angle with the horizon greater than one-half degree.

"A remarkable feature in regard to this change of slope which occurs in the neighborhood of the course of the Niobrara is the shortness of its tributaries, the surface drainage seeming to be away from and not towards its banks. A result of this is the absence of the amphitheatre-like valley which rivers generally have, and which enable us to look down at the stream often many miles distant. Through the greater portion of the middle half of its course you have scarcely any indication of it as you approach, till within close proximity, and then you look down from the steep bluffs, and catch, at the distance of two hundred to five hundred yards, only here and there a glimpse of the river below, so much is it hidden by the precipitous bluffs which at the bends stand at the water-edge. So strongly was I impressed with the fact that the surface drainage could never have been directed along its course so as to have worn out this channel, that I think a portion of it must have originated in a fissure in the rocks which the waters have since enlarged and made more uniform in size, and which the soft nature of the rock would render easy of accomplishment. It is worthy of remark, in this connection, that the bed of the stream in longitude 102° is four hundred feet higher than that of the White river at the point nearest to this; White river having there cut its way entirely through the tertiary formation, flows along the cretaceous, while the bed of the Niobrara is in the miocene tertiary, the pliocene forming the bluffs. The bed of the Niobrara is also, in two-thirds of its upper course, from three hundred to five hundred feet above the bed of the Platte river at corresponding points at the south.

"In the section of the country through which the Niobrara flows the soil is very sandy, so that what rain or snow falls sinks under the surface, and none is lost by evaporation. This is gradually all poured into the stream by the springs in the ravines, and in this way the river is mainly supplied in seasons of low water, at which times it is one of the largest streams of Nebraska."—pp. 60, 61.

WARREN'S MAP TO ACCOMPANY THE PACIFIC RAILROAD REPORTS.—A map prepared under the direction of the Secretary of War, to accompany the Pacific Railroad Reports has been published on a scale of 1 to 3,000,000, including the country, so far as surveyed, between 26° and 49° N. lat. and 90° and 122° W. long. It is prepared by Lieut. G. K. Warren, U. S. Topog. Eng., acting under the department of Explorations and Surveys, of which Capt. Humphreys is director. In its construction, not only the results of the Pacific R. R. Exploring Expeditions, and those of the Mexican Boundary Commission, but all the earlier investigations, which are reliable, including those of Lewis and

Clarke, 1804–6, Long, 1819–23, and many of a more recent date, have been collated and employed. Although much information is yet wanting in respect to the vast regions thus delineated, the map is an important embodiment of what has been ascertained.

CAPT. HUMPHREYS'S REPORT ON THE PROGRESS OF U. S. EXPLORATIONS AND SURVEYS.—The report of Capt. A. A. Humphreys, of the office of Explorations and Surveys, under the Secretary of War, presented to Congress at its recent session has been recently distributed. In addition to a statement of Lieut. Warren's operations, the following particulars are given.

1. The experiment of sinking artesian wells on the public lands has been prosecuted by Capt. Pope so far as to demonstrate that with any reasonable amount of expenditure, artesian wells on the Llano Estacado, and plains of similar formation and position, are impracticable. A well was sunk to the depth of a one thousand and fifty feet; beyond that depth it could not be carried. Apprehensions are even entertained as to whether the water would flow at the surface, if the boring were carried to the depth originally intended.

2. The field work of the exploration of the Rio Colorado of the West has been completed, and the report and maps are now in preparation. The river was ascended by steamboat to a point nearly 500 miles from its mouth (lat. 36° 06′), beyond which it was impracticable to proceed in boats. The ascent occupied about 70 days, but is said to be practicable in ten or twenty days by steamboats of suitable construction and two feet draft. The head of navigation is 220 miles from the first Mormon settlement in the Great Lake Basin, and 500 from the Great Salt Lake.

3. The explorations recommended for the next season are the examination of the interior of Nebraska, especially the sources of the Yellowstone; the region along the San Juan to its junction with the Rio Colorado of the West, and along the Spanish trail from that river to Abiqui; the route across the Sierra Nevada to Carson's river to ascertain its railroad practicability and the upper Columbia river to ascertain its navigability.

DIETERICI'S ESTIMATE OF THE POPULATION OF THE WORLD.—Prof. C. F. W. Dieterici, Director of the Statistical Bureau of Prussia, presented to the Berlin Academy of Sciences in March, 1858, an estimate of the population of the earth, which is printed in Petermann's Journal for January, 1859, together with two other articles from the same pen, giving corresponding estimates for the different races and religions. Dr. Petermann has accompanied the articles with a map of the world, exhibiting at a glance the comparative density of the population in different parts of the globe. The eminence of Dieterici as a statistician gives peculiar value to these estimates. We quote his results,

remarking that the data upon which they are based are given in the journal above referred to.

1. *Total Population of the Earth.*

	Square miles.*	Inhabitants.	Inhab. to sq. m.*
Europe,	182,571	272,000,000	1490
Asia,	793,964	755,000,000	951
Africa,	543,570	200,000,000	368
America,	750,055	59,000,000	79
Australia,	161,452	2,000,000	12
South Polar lands,	2,288		
In the world,	2,433,900	1,288,000,000	529

2. *Population of the Earth by Races.*

Caucasian,—	Europe,	270,000,000
	Asia,	36,000,000
	Africa,	4,000,000
	America,	58,000,000
	Australia,	1,000,000
		369,000,000
Mongolian,	Asia,	522,000,000
Ethiopian,	Africa,	196,000,000
American,	(The Indians,)	1,000,000
Malay,	Asia & Austr.	200,000,000
		1,288,000,000

Or, in round numbers, we may say that of 1,300,000,000 inhabitants of the globe, 375,000,000 are Caucasian, 528,000,000 Mongolian, 200,000,000 Malay, 196,000,000 African, and 1,000,000 American; or by percentage, 28·85 are Caucasian, 40·61 Mongolian, 15·38 Malay, 15·08 African, and 0·08 American.

3. *Population of the Earth by Religions.*

Christians,	335,000,000	or	25·77 per cent.
Jews,	5,000,000	or	·38 " "
Asiatic religions,	600,000,000	or	46·15 " "
Mahommedans,	160,000,000	or	12·31 " "
Heathen,	200,000,000	or	15·39 " "
	1,300,000,000		

The Christians include

Roman Catholics,	170,000,000	or	50·7 per cent.
Protestants,	89,000,000	or	26·6 "
Greeks,	76,000,000	or	22·7 "

FERNANDO DE COSTA LEAL'S REPORT OF THE EXPEDITION TO THE MOUTH OF THE RIVER CUNENE, SOUTHERN AFRICA. —The accounts already published of Dr. Livingstone's explora-

* These are German square miles, one of which equals sixteen English sq. miles.

tions in Southern Africa, and the earnestness with which this intrepid traveller has engaged in a new expedition, give a peculiar interest to all investigations in that part of the world. Among other inquiries which have long been unsettled, the extent and course of the River Cunene, or Nourse, emptying into the Atlantic Ocean, in lat. 17° 30′ S., now appears to be determined. Pimentel, Chapman, Owen, and others had given concerning it such contradictory accounts, that at one time it was supposed to be a large river furnishing the readiest access to Central Africa, and navigable for the largest ships, and at another it was doubtful whether it even extended to the ocean.

A Portugese expedition, in 1854, undertook to ascertain the truth, proceeding from Mossamedes, a colony on the west coast of Southern Africa, to the mouth of the Nourse, and then ascending the river a considerable distance. In Petermann's Journal (1858, p. 412) an account of this expedition and its results is given from the manuscript just received, of Fernando de Costa Leal. We translate the entire article. It is dated Mossamedes, Nov. 24, 1854, and is as follows.

For a considerable time past mention has frequently been made of the River Cunene, the fertility of its banks, and its mineral wealth; but these communications from the traders of the Desert contained nothing in reference to the mouth of the river, and hence it remained undetermined whether the river was navigable throughout its course.

The mouth of the river is on the west coast and not upon the east, as is erroneously represented on the chart to the 'Investigations of Lopez de Lima into the Statistics of our transmarine Possessions.'

According to the representation of the Bush traders respecting the course of the river, and the account of the Muimbas and Musimbas, tribes living upon the left shore of the Cunene, this river has its source in the land of Nano (which, in the language of the natives, means Highlands), constitutes the boundary between Molomba and Kamba, passes by Canhama, situated on its right bank, and then curves round to the coast, below 17° 51′ south latitude.

With a view of rendering a service to my country, I determined to proceed, in person, to the mouth of the river, in order to convince myself of what degree of importance it might prove to the interests of the commerce with Africa. I accordingly sailed from Mossamedes Bay in the schooner 'Conselho,' on the 3d of November, in company with Messrs. Bernardino da Castro, director of the colony, A. A. de Oliveiro Cavalho, Josè D. Franco, and Antonio R. Franco, who had expressed an earnest desire to accompany me. We sailed southward, and arrived at the northern point of the Great Fish bay on the 8th of Novem-

ber. This bay, 6½ miles in breadth, is bounded on the east by immense sandy plains, and on the west by a peninsula of sand; it affords most convenient shelter to ships of every size, and abounds in fish; great profits would be realized from fisheries here established.

The surrounding region presents no trace of vegetation, save a small plant of the genus *Cactus*, but fresh water can be obtained in the immediate vicinity, and upon the coast towards the south, an area of about 30 miles in extent is thickly strewn with trunks of trees, which have been carried, during the great freshets, from the banks of the Cunene to the ocean, and have been thrown by the waves upon the coast to the north of its mouth.

As we approached the head of the bay, it seemed as though a forest and a large sea lay before us, which gave to the country a charming appearance. This vanished in a few moments, for the mirage had converted the smallest bushes into forest trees, and what appeared to be a sea in which were mirrored the large trees and other lofty objects, proved to be only a sandy plain! We spent November 8th, 9th and 10th in the bay. Our object originally was to proceed to the mouth of the river by sea, but since the exact situation of that point was but little known, and it had been reported that we should find the entrance difficult, as well as be unable to come to a secure anchorage, we determined to prosecute the remainder of the journey on land along the coast.

After the necessary preparations had been made, the entire company, consisting of ten whites and eleven negroes, disembarked, and we proceeded on our journey on foot. The shifting sand and the hot sun made our advance slow and tedious; at 5 o'clock P. M. we pitched our tent on the borders of Esponjas (the swamps). On the morning of the 12th we continued our march southwards, advancing over huge beds of granite, which were intersected by basaltic dikes; on our right were still seen the dunes of sand. Our progress was now rendered more easy, and after having advanced twelve miles, we halted for the night near the coast, although not the smallest trace indicated the proximity of the river. A small supply of water remained, with no expectation of our being able to obtain any in the immediate vicinity. Two persons were sent to some distance into the interior, and directed to dig pits for the purpose of obtaining water, but their efforts were fruitless. In no wise disheartened, firmly resolved to overcome all the difficulties of our march, a few other persons set out with the same object in view. In the evening, at half past 9 o'clock, they returned from their successful expedition, bringing two vessels full of clear and fresh water which they had taken from the river only 4½ miles distant from us.

Filled with joy and anxiously awaiting the break of day, we spent the night, and at 4 o'clock in the morning we struck our tent; at 5½ o'clock we reached the right bank of the Cunene, about 1½ leagues from its mouth. We followed the course of the river from this point to its mouth. Here we found that the mouth is completely closed up by a sand bank, which is overflowed only at times of high tide; at other times the water is lost in the sand. Pimental, in his Descriptions makes the remark, that the current of the river can be traced in the ocean for several miles; he also designates the course to be pursued with a boat on attempting the entrance into the river. I am convinced that this navigator passed at the time of high tide, and regarded this as the usual depth of the stream, hence he failed to remark this circumstance. Had we prosecuted the rest of our journey by sea, we would in all probability have determined very little in reference to the river, from the fact that the sand-bank is very high, and completely connected with the banks of the river at its mouth. This would certainly have been the result unless the latitude of the river had been previously determined with accuracy. Even if we had succeeded in discovering the river, the sea, very rough at this point, would have exposed the boat to great peril.

Near the coast, upon the right bank of the river, vegetation is quite abundant, and we met there with great numbers of deer, antelopes and goats. The sea coast takes a south-southeasterly direction, and affords not the least protection. The stream near the sand-bank is very shallow, too much so even to carry a flat-bottomed boat. The banks are but slightly elevated, formed of sand and pebbles, and covered with some vegetation. On our return to the camp, an elephant presented himself to our view, on the opposite bank, and in spite of the perils from the crocodiles swarming the river, to which our hunters were exposed, they crossed in safety and speedily drove the elephant into the interior.

On the 14th of November we followed up the course of the river on its right bank, observing on both sides of the river large piles of wood and thick trunks of trees similar to those seen upon the sea coast. The banks gradually rose to greater height, the stream grew narrower, but thus far no obstructions in the bed of the river were met with; after a two *hours* march we fell in with high waterfalls. Sand dunes constituting the left bank, and perpendicular masses of granite rock the right bank, compelled us to leave the shore and we only returned to it after a march of 4½ hours. The deep winding valleys which intersected the surface in this region, rendered this portion of our march much more wearisome than the earlier portion of it. Finding it impossible to advance any farther on this day, we re-

turned to the river in order to halt for the night on its banks. We found here an agreeable and picturesque spot, vegetation rather rich, consisting mostly of cedar trees, of a size far inferior to the European cedar. The banks here were less elevated, and afford an easy passage, although large rocks abound in the river; and upon the left bank sand-dunes are still seen. At this point we met with many traces of the elephant, zebra, the deer, the fox, the monkey, and the lion. The direction of the stream is N. ¼ West.

We resumed the march on the following day, with no expectation of replenishing an almost exhausted stock of provisions. We halted at 9½ in the morning, and after disposing of the remainder of our provisions, were on the point of turning back, when very luckily one of our soldiers killed a young elephant that accompanied by its dam had ventured within range of our guns. Soon after we resumed our march. The general appearance of the region through which we were advancing was the same, with this exception, that the vegetation seemed to be more fully developed, and the traces of the various animals, especially the elephant, became more numerous. This led us to believe that farther in the interior, great herds of elephants frequent the banks of the Cunene, which at certain seasons of the year, advance towards the mouth of the river. From the source of the stream to the point which we were able to attain, a distance of about 21 miles, we fell in with eight elephants, which all withdrew into the interior.

Up to this point the Cunene presents no points of any importance; its course is winding, the bed of the river narrow and obstructed by waterfalls, and hence not navigable. For even if these were to be removed, (which is not impossible,) yet the mouth of the river could not be cleared; for the current of the river, removing the sand-dunes on the left bank constantly deposits them near the mouth where the water is shallow and the current not so strong. Whether the Cunene be navigable at any point, we are as little able to say, as at how great a distance the tribes living on its banks kept themselves from us.

We discovered a mountain range of considerable height, running in a direction from north to south; but it was impossible for us to cross this range, since we were in no respect furnished with the necessary means. Our mission being quite a different one and already accomplished, we commenced our journey homeward on the 16th of November, and arrived at the Great Fish Bay on the following morning at 10 o'clock. The extent of our whole journey on foot being about 30 miles.

The result of the expedition is already apparent. Many of the inhabitants of Mossamedes, engaged in the trade of the desert, are preparing themselves for an excursion by land to the

banks of the Cunene. If a friendly intercourse with the people of this region be kept up, the colony will here find a new source of trade and wealth. This would result in leading that nation to carry on a direct trade with Mossamedes, after the example of the people of Gamba, Huilla, Jau, Humputa, Quillengues, Humbe, Kamba, Mulonde, and other places. D. C. G.

Yale College Library, April, 1859.

ART. XLII.—*On a new Sulphid of Copper and Lead;* by FREDERICK FIELD.

IN the 'Mina Grande' near Coquimbo, Chili, there exists a mineral containing sulphur, lead and copper, in certain proportions which render it highly interesting. From the same mine have been obtained the following ores of lead: vanadiate of lead, vanadiate of lead and copper, arseno-phosphate of lead, sulphate of copper and lead, and carbonate and sulphid of lead, besides an intimate mixture of sulphid and sulphate of lead, the former mineral evidently undergoing gradual oxydation.

The double sulphid of copper and lead has the following properties. Sp. gr. 6·10. H. from 2·5 to 3. Massive. When broken, a slight conchoidal fracture, having a deep indigo-blue color, quickly tarnishing on exposure to the atmosphere. Immediately associated with carbonate of lead and carbonate of copper.

The pure mineral is violently acted upon by nitric acid, with the formation of sulphate of lead and liberation of free sulphur. 100 parts yielded—

Copper,	53·66
Lead,	28·25
Sulphur,	17·00
	98·86

corresponding to $3Cu_2S, PbS$, which requires Cu 53·33, Pb 28·88, S 17·77.

The only other simple combination of sulphid of copper and lead with which I am acquainted is the cupro-plumbite of Plattner, (also from Chili,) which is a compound of $Cu_2S, 2PbS$.

I have proposed the name *Alisonite* for this mineral, in honor of R. E. Alison, who has spent many years in developing the mineral wealth of Chili.

Guayacan, Coquimbo, Jan. 29, 1859.

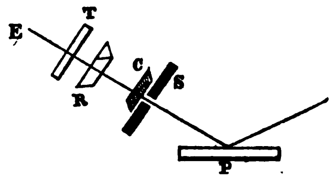
APPENDIX.—In a letter to one of the editors of the same date, Mr. Field observes, that the mineral described by him under the name of *Guayacanite* (this volume, p. 52), he has found to be the rare species Enargite.

ART. XLIII.—*An Abstract of Prof. von Kobell's Stauroscopic Observations;* by OGDEN N. ROOD, Professor of Chemistry in Troy University.

THE following pages contain a brief abstract of Prof. von Kobell's observations with the *stauroscope*, an optical instrument lately invented by him and designed to be used in optico-crystallographical researches.*

In a previous number of this Journal† the instrument was described and figured; the annexed diagram will therefore be sufficient to point out its optical arrangement.

1.



P is a plate of glass which reflects polarized light toward the eye at E, S is the stage-plate or engraved square, C the crystal under investigation, R a plate of calc spar cut at right angles to its optic axis, and T is the analyzing tourmaline. During the experiments the stage-plate S with the crystal is revolved about the axis EP, the rest remains stationary.

I have found it much better to use two Nicol's prisms instead of the glass plate and the tourmaline, and in my own experiments at the end of this article they were employed exclusively.

The plate of calc spar being in its proper position, the tourmaline is turned so as to darken the field, and upon looking through the instrument the usual black cross is seen, of which we shall afterwards speak, surrounded with its concentric colored rings. The dark field which would be seen without the plate of calc spar is more sharply defined by the cross.

When the third cylinder is put in, its slider fitted to the second, and the divided circle turned around to zero, then two sides of the engraved square coincide in position with the axis of the tourmaline. If it be wished to determine the directions (or planes) in which the polarized rays of a double refracting crystal vibrate with regard to the edges of the observed crystal plane, the crystal is to be fastened with wax on the engraved plate over its opening, and turned till one of its sides is parallel with one of the sides of the engraved square, the cylinder with the crystal is then slid in, and the graduated circle turned to 0.

* See von Kobell's "Mineralogie," 2nd edit. 1858, p. 47.
† Vol. xix, 2nd Series, p. 425, and xx, 415.

If the cross is seen unchanged in its position then the polarized rays of the crystal vibrate in the direction of the side of its plane and at right angles to it, but if no cross should appear, or if it should be changed in its position, it is a proof that the rays do not vibrate in the direction of the edge of the crystal plane under observation, and it is necessary to turn the cylinder to which the crystal is attached a certain fixed number of degrees till this happens and the cross again appears in its upright normal position; the angle is read off by means of the vernier. In this manner it is possible to obtain through the stauroscope certain characteristic optical distinctions for the different crystalline systems, by which they often may be determined when other means fail.

I. *System of simply refracting crystals.*

MONOMETRIC SYSTEM.

Monometric crystals show, in every position in which they can be put on the stage, the cross normal; however the stage may be turned it remains unchanged.

Examples: Rock salt, alum, spinel, fluor. Amorphous pieces behave in the same manner.

II. *Systems of doubly refracting crystals.*

All doubly refracting crystals show in certain directions the cross *inclined*, or by revolving them they *extinguish* the normal cross; it is only in the directions of their optic axes that they behave to a certain extent like monometric crystals.

Systems with one optic axis.

1. DIMETRIC SYSTEM.

(1.) Seen through a plane of the quadratic pyramid the cross arranges itself according to the verticals of the triangle or at right angles to each of its sides.

(2.) Through the prismatic faces the cross has the position of the principal axis.

(3.) Through the basal plane the cross appears normal and remains unchanged when the crystal is revolved.

Examples: Apophyllite, idocrase, zircon, scapolite.

2. HEXAGONAL SYSTEM.

(1.) Through a plane of the hexagonal pyramid the cross stands in the directions of the verticals of the triangle or at right angles to each of its sides.

(2.) Through the sides of the rhombohedron the cross arranges itself in the directions of the diagonals.

(3.) Through the faces of the scalenohedron the cross arranges itself according to the lines of altitude of the sides of its holohedral dihexagonal pyramid, or at right angles to the sides of its horizontal twelve-sided transverse section.

(4.) Through all the prismatic sides the cross is seen normal in the direction of the principal axis.

(5.) Through the basal plane the cross is seen normal and unchanged by the revolution of the crystal.

Examples: Apatite, quartz, calcite, chabazite, emerald.

Systems with two optic axes.

In these systems there occur no planes through which the normal cross remains unchanged during the revolution of the crystal.

3. TRIMETRIC SYSTEM.

(1.) Seen through a plane of the rhombic pyramid the cross makes *three* angles with the three sides, corresponding to the inequality of the sides of the triangle.

(2.) Through the prismatic faces and also through the macro- and brachy-diagonal planes the cross is in the direction of the principal axis, also through the domes it is in the direction of the dome edge.

(3.) Through the basal plane when it is rhombic the cross stands in the direction of the *diagonals*, when it is rectangular in the direction of its sides.

By revolving the crystal the cross becomes pale or is altered by colors.

Examples: Heavy spar, topaz, sulphate of magnesia, aragonite, chrysolite.

4. CLINO-RHOMBIC OR MONOCLINIC SYSTEM.

(1.) Through the lateral planes of the oblique rhombic prism the cross is inclined to the principal axis; also through the planes of the clinodome it is inclined to the dome-edge. The angle through which it is necessary to turn is the same for like planes, and the crosses are turned towards or away from the clinodiagonal chief section to the right or left with equal angles, when seen respectively through the back or front sides of the crystal.

(2.) Through the orthodiagonal plane the cross is normal in the direction of the principal axis.

(3.) Through the clinodiagonal plane the cross is inclined to the principal axis.

(4.) Through the basal plane of the rhombic prism the cross stands according to the diagonals.

Examples: Diopside, selenite, orthoclase, epidote, borax.

5. TRICLINIC SYSTEM.

The cross appears through every plane inclined at a certain angle, when any one of the planes or corresponding edges of the crystal is placed horizontal or vertical on the engraved stage.

Examples: Kyanite, albite, sulphate of copper.

ART. XLIV.—*Stauroscopic and other Optical Experiments;* by Prof. OGDEN N. ROOD.—Part I.

1. *Stauroscopic Observations on Cooled Glasses.*

IN the Stauroscopic observations of Prof. von Kobell plates of crystals with natural or artificial parallel sides were employed, and it is of course a matter of indifference through which part of the plate the polarized beam is transmitted, the phenomena observed being the same whether the centre or any of the edges be employed. The case is however different with plates of glass of a definite shape to which double refraction has been communicated by sudden cooling from a red heat or otherwise.

Having arranged a stauroscope with an open stage I submitted to examination pieces of glass of different figures to which double refraction had been thus communicated; the following are some of the *simpler* results obtained.

1. Through the centre of the equilateral triangle the cross arranges itself in three positions, at right angles to its three sides; the cross is of course not stationary when the triangular plate is revolved. The same is true when the polarized beam is transmitted through three spaces near the middle of its sides.

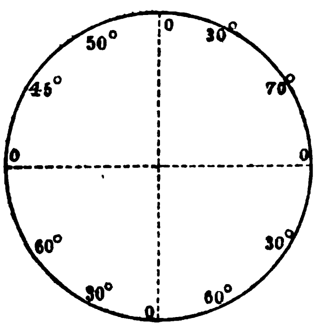
Through the angles of the triangle the cross is *inclined* to the above mentioned planes.

I found no spot in the triangle where the cross remained unaltered when the glass plate was revolved.

2. Through the centre of a circular plate of glass the cross remained tolerably unaltered by revolution, this position of the plate corresponds therefore to the basal plane of a crystal belonging to the dimetric system.

Through the spaces 0, 0, 0, 0, the crosses are altered by revolution and arrange themselves in the positions of the dotted lines. Seen through the spaces marked with figures the crosses arranged themselves at these angles to the dotted lines.

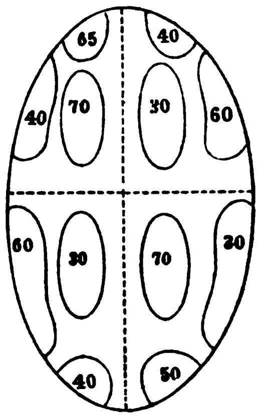
1.



3. Through the centre of an elliptically shaped plate the cross was altered by revolution and arranged itself in the directions of the major and minor axes. The same is true for the spaces along the dotted lines.

The inclinations of the crosses to the axes of the ellipse in different portions of the plate will at once be seen by the annexed diagram, and also that the arrangement of the outer portions is essentially the same as in the circle, the main difference being in the occurrence of the oval-shaped spaces on either side of the foci.

2.

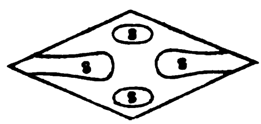


4. Through the centre of the *square* the cross remains tolerably unchanged by revolution; near the middle of its sides the cross is altered by revolution and arranges itself at right angles to the sides.

In the angles it was inclined to the sides of the square at angles of from 30° to 50°. In a perfectly evenly cooled plate it would probably arrange itself according to the diagonals.

5. Through the centre of a rhombic-shaped plate the cross arranged itself parallel to *only* two sides of the rhomb; it remained always somewhat colored. (See under circular polarized light.) Through the spaces *s*, *s*, *s*, *s*, it arranged itself according to the diagonals.

3.

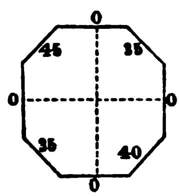


6. Through the centre of a rectangle, whose length was four times its breadth, the cross arranges itself according to the diameters: in the angles the crosses are *inclined* at certain angles to the diameters.

When two pieces of this shape are laid one upon the other, parallel or at right angles, and viewed through their common centre, the cross still arranges itself parallel and at right angles to their sides.

When the plates were inclined 45° to each other no black cross was seen in any position; in its place a red or green nebulous cross appeared at all inclinations. (See below.)

4.



7. Through the centre of an octagonal shaped plate the cross remained tolerably unaltered by revolution; in the spots marked 0 the cross was altered and arranged itself accordingly to the dotted lines; in the spaces marked with numbers the crosses made these angles with the dotted lines.

From these observations it will be seen that the crosses remain unaltered when viewed through the centres of regular polygons, as for example, the square, the octagon, and the circle, the latter being considered a regular polygon with an infinite number of sides; the *centres* of such polygons are therefore uniaxial and correspond to the basal plane of uniaxial crystals: the positions of these solids which I have marked 0 correspond with the *prismatic faces* of uniaxial crystals; the portions marked with numbers correspond in a certain sense with the planes of the quadratic pyramid. It is remarkable that we should have in portions of one plate a representation of the action of all the planes of a *crystal.*

The central portions of the ellipse and rectangle correspond to the basal plane of a crystal belonging to the rhombic system; the rhombic plate of glass had not been cooled with sufficient regularity to base a conclusion on its action though indications were observed which would place it along with the ellipse—at all events the spots marked *s* acted like the rhombic shaped basal plane of a rhombic prism.

The centre of the triangle corresponds in action to a plane of the quadratic pyramid.

2. *Observations on Circular Polarization by means of Cooled Glasses.*

(1.) The celebrated physicist, Dove, found when a *cube* of glass was suddenly cooled and afterwards placed in a polarizing apparatus and inclined 45° to the plane of primitive polarization, that the plane polarized beam was converted into circular polarized light by transmission through the corners of the square plate; this he proposed as an easy method of producing circularly polarized light.

I have found that when a beam of polarized light is transmitted through the centre of a *rhombic* shaped plate of glass (see above) which had been thus treated that the light was more or less circularly polarized *whatever the position* of the rhomb with regard to the plane of primitive polarization might be, though the experiment succeeded more strikingly when its position corresponds to that of Dove's cube. The polarization was right-handed, and the colors were as brilliant and followed each other with as much regularity as when seen through a quartz plate cut expressly for this purpose.

(2.) Through the centre and portions along the major diameter of an elliptically shaped piece of glass the light is also circularly polarized when either of the axes are inclined at angles of 45°, 135°, &c., to the plane of primitive polarization. The polarization was right-handed, and in both these cases a *large beam of circular polarized light* was obtained; by changing the angle of the

plate with the plane of primitive polarization I easily obtained elliptically polarized light, the axes of the ellipse having any desired relation to each other.

(3.) Through the centres and along the chief diameters of rectangular shaped pieces of glass, whose length was four times their breadth, the light was also circularly polarized when the inclination was 45° to the plane of primitive polarization. When two rectangles were crossed at an angle of 45° and placed as above, the light was more completely circularly polarized, it was found to be *right-handed;* upon reversing the inclination of the rectangles to each other the beam was turned to the *left hand.*

It will be seen therefore that by means of two similar rectangles of cooled glass, either right or left-handed circular polarization may be obtained at pleasure, an observation I believe which has never before been made.

(4.) The light in all the angles of the octagon was circularly polarized.

3. *On the appearance presented by circularly polarizing crystals, &c. in the Stauroscope. The cross a means of detecting circular or elliptical polarization.*

If a plate of quartz be cut at right angles to its axis and of such thickness that for example it gives the yellow tint when placed in the field of a polariscope, then when introduced into the stauroscope it will modify in a certain manner the cross and the colored rings.

(1.) No *black* cross will be seen in any position of the quartz plate; in its place a *yellow* cross appears which remains stationary and in its normal position when the quartz is revolved, and the white quadrants next to the calc spar cross are replaced with patches of red and blue color.

(2.) When the analyzing plate is revolved the yellow cross *revolves with it,* passing at the same time through all the prismatic tints, the rings not being greatly changed. If the plate is thicker or thinner than the above mentioned, the initial cross will merely in the first instance be differently tinted, but the color will in every case be the same with that which the whole plate would have if placed in the darkened field of a polariscope; the rest of the phenomenon remains the same. The circular polarized light obtained through cooled glass acted in exactly the same manner.

I have found this colored cross, stationary and revolving, an excellent means of detecting circular polarized light when it would otherwise have been overlooked, that is, when such a brilliantly colored cross is seen which revolves with the analyzer through the whole circle, changing always in tint but never becoming black, it is a proof that the light is *circularly* polarized.

When the polarization is elliptical a colored cross it is true will be seen and it will revolve with the analyzer and change in tint, but at angles of 180° it becomes normal and nearly black.

Of course light occurs in every state of polarization, passing from elliptical through circular to plane, according to the relative dimensions of the axes of the ellipse, but after some practice it is possible by means of the cross to judge of these dimensions approximately.

In examining this matter, besides using plates of quartz, &c., I constructed an apparatus for producing plane, circular, or elliptical polarization by means of the inclinations to the plane of primitive polarization given to a lamina of mica of a certain thickness, the state of polarization of the light from the mica was examined with a doubly refracting rhomb of calc spar before observing the cross.

Troy University, Dec. 25th, 1858.

Art. XLV.—*On Boltonite;* by Prof. Geo. J. Brush.

The identity of this mineral with chrysolite was pointed out by Professor J. Lawrence Smith in this Journal, vol. xviii, p. 372 (November, 1854). Previously to this Dr. Kenngott* endeavored to show from analyses made by v. Hauer that boltonite was a distinct species. Subsequently† Kenngott calls in question Smith's conclusions: from v. Hauer's analyses he draws the formula $\dot{R}^5\dddot{Si}^3$, and insists that this, together with the low hardness (5·5) of the mineral, shows that boltonite is not chrysolite. In Dr. Smith's examination, the mineral was as carefully selected from the gangue as possible and then freed from adhering carbonates by repeated treatment with dilute hydrochloric acid; afterwards great care was taken in choosing for analysis the purest of the fragments thus treated. Three analyses made upon specimens so selected gave:

	$\dddot{Si}$	$\dot{Mg}$	$\dot{Fe}$	$\dddot{Al}$	Ignition.
1.	42·56	51·77	2·35	0·10	2·22 = 99·00
2.	41·95	51·64	3·20	0·25	1·58 = 98·62
3.	42·41	50·06	3·59		not. det. ——

which excepting the slight amount of loss by heat (not necessarily water) indicate a perfect correspondence with chrysolite.

Von Hauer did not find it practicable to separate the boltonite from the gangue, but analyzed a specimen with the accompanying gangue. In his first analysis the mineral was decomposed by fusion with carbonate of soda. His results gave—

* Mineralogische Notizen, Zwölfte Folge (March, 1854).

† Uebersicht der Resultate mineralogischer Forschungen im Jahre, 1854. Leipzig, 1856.

	$\dddot{Si}$	$\dot{Fe}$	$\dot{Ca}$	$\dot{Mg}$	$\ddot{C}$
No. 1.	13·32	3·80	29·00	21·17	32·71

The carbonic acid (32·71 per cent) was determined by the loss.

In the second analysis, made upon the same mixture, the mineral was treated with dilute hydrochloric acid, and the bases in the acid solution were determined and *calculated* as carbonates. The insoluble portion was decomposed by fusion with carbonate of soda. The magnesia in both the soluble and insoluble portions were determined *by the loss.* Analysis No. 2 gave—

$\dot{Fe}\ddot{C}$	3·37	72·70 soluble in H Cl.
$\dot{Ca}\ddot{C}$*	50·93	
$\dot{Mg}\ddot{C}$	18·40	
$\dddot{Si}$	12·85	27·30 insoluble in HCl.
$\dot{Fe}$	1·74	
$\dot{Ca}$	0·94	
$\dot{Mg}$	11·77	

Assuming the carbonic acid (which was determined by the loss) in No. 1 to be combined with the bases in the same manner as found in No. 2, Kenngott shows that No. 1 contained 28·64 per cent insoluble in acid. The percentages of the substances in the insoluble portions in both analyses would then be:

	$\dddot{Si}$	$\dot{Mg}$	$\dot{Fe}$	$\dot{Ca}$
1. (*a*)	46·50	43·89	6·08	3·53
2. (*a*)	47·07	43·11	6·38	3·44

Kenngott calls attention to the close correspondence between the analyses and insists that the method employed by v. Hauer to obtain the true composition of boltonite is quite as satisfactory as that adopted by Smith.

It is however worthy of remark, that the carbonic acid in both of v. Hauer's analyses was determined by the loss, that the magnesia in both soluble and insoluble portions in No. 2 was also determined by the loss, and that the errors have been increased more than threefold by the manner in which the analyses were calculated. It may well be questioned whether conclusions based upon analyses made in such an indirect manner should be permitted to throw doubts on analyses of carefully selected material where everything was determined directly.

The fundamental point in the conclusions which Kenngott draws from v. Hauer's analyses depends upon the assumption† that boltonite is not attacked by dilute hydrochloric acid, for in

* In the analysis the $\dot{Mg}\ddot{C}$ is stated to be 50·93 and $\dot{Ca}\ddot{C}$ 18·40, but the remarks that follow show that this inversion is a typographical error.

† To avoid misrepresentation on this important point I quote from the original article, p. 27 of the 12th No. of Kenngott's *Mineralogische Notizen:* "Da aus der Analyse hervorgeht, dass das Grundgestein kein reiner Calcit ist, auch der Einfluss der Luft auf das Grundgestein zeigt, dass es Eisenoxydul enthält, so wurde eine zweite Probe desselben Gemenges mit sehr verdünnter Salzsäure digerirt, wobei das Silicat, der Boltonit, gewiss nicht angegriffen werden konnte."

No. 2 the portion insoluble in dilute hydrochloric acid was considered to be pure boltonite, and from this was calculated the composition of boltonite as given in 1 (*a*) and 2 (*a*).

But I have found by experiment that boltonite is acted* upon even by very dilute hydrochloric acid, and this being the case, the insoluble portion in v. Hauer's analysis must have contained an excess of silica derived from the partial decomposition of boltonite by dilute acid. It is therefore evident that any conclusions in regard to the composition of boltonite based upon the analysis of this insoluble portion must be erroneous. This partial decomposition of boltonite also affords a satisfactory explanation of the excess of silica in v. Hauer's analysis over that obtained by Smith.

It is unnecessary to follow Kenngott farther, as I shall proceed to show from my own analyses the correctness of Smith's conclusions.

In the year 1854 I made an examination of boltonite, but not being entirely satisfied with the purity of the substance analyzed, the analysis was not published. The mineral was separated from the gangue by acetic acid and selected as carefully as possible. Fused with carbonate of soda it gave—

Si	Mg	Fe	Ca	Al	Ignition.
40·94	50·54	4·37	1·20	0·27	3·28 = 100·60

Disregarding the ignition, the result confirmed Dr. Smith's analyses, but I could not be certain that the mineral was perfectly pure, and it was not until a few weeks since that Prof. C. U. Shepard kindly placed at my disposal a specimen containing large irregular crystals of boltonite from which I have been able to select the mineral pure for analysis.

It occurs in a magnesian limestone in crystals which are sometimes more than an inch in diameter; these irregular crystals implanted in the gangue often present rectangular sections, and have a very distinct cleavage in one direction. The color of the specimens I examined was dark ash-grey, but small fragments were almost colorless. It scratches feldspar, and therefore the hardness is 6 or a little above. Its specific gravity is 3·21. Before the blowpipe in platinum forceps it does not fuse but the color changes to light-yellow; with salt of phosphorus gives reactions for silica and iron. When treated with very dilute hydrocloric acid (i. e., one part acid to ten parts water) the powdered mineral is partially decomposed. In the quantitative analysis the mineral was first powerfully heated over a blast lamp and subsequently decomposed by carbonate of soda. The analysis gave—

* Dr. Smith also alludes to this fact *loc. cit.*

		Oxygen.		Ratio.
Silica,	42·82	22·25	22·25	1
Magnesia,	54·44	21·77		
Protoxyd of iron,	1·47	·33	22·34	1
Alumina,	*trace.*	——		
Lime,	0·85	·24		
Ignition,	0·76			
	100·84			

This ratio gives the formula of chrysolite $\dot{R}^3 \dddot{Si}$. The analysis fully confirms Dr. Smith's conclusions, and shows that boltonite is a *magnesian* chrysolite, that is, unlike other varieties of the species, it is a silicate of magnesia and not of magnesia and iron.

Yale Analytical Labratory, Dec. 1st, 1858.

Art. XLVI.—*Varying Level of Lake Ontario;* by Prof. C. Dewey.

In vol. xxxiii of this Journal I gave the varying temperature of Lake Ontario in 1837, and confirmed the result by observations in vol. xxxvii. The variations in the level of this lake, as well as of the other great lakes of this chain of waters, has been the subject of much observation and of many singular, if not absurd, traditions and speculations. The want of measures, known to be reliable, has been a great support of these fancies. In the following Table the remedy is in part attained. The measures were made at the Port of Genesee, Charlotte, at the mouth of Genesee River, by order of the Government. They have been reported annually in the local papers, and in the Regents' Report, and I now present the measures and results obtained for the thirteen past years.

Variations of the Level of Lake Ontario, for the enumerated years, measured from a fixed point downwards to the water.—The *larger* the measure, the *lower* the level.

TABLE.—Measure in inches.

Years.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Mean	Range	Relative.
1846	51	54	48	45	42	39	39	42	45	45	48	45	45·2	15	Low.
1847	48	42	36	36	29	25	25	25	36	39	43	46	35·8	23	Bel'w mean.
1848	29	34	43	38	38	37	38	39	44	49	54	53	41·3	25	" "
1849	50	50	52	46	36	33	44	39	45	38	38	41	42·7	19	" "
1850	45	40	40	40	32	29	34	46	47	52	55	43	41·9	26	" "
1851	44	54	48	47	44	38	35	38	42	47	53	51	45·0	19	Low.
1852	50	51	48	44	26	26	22	24	30	23	38	34	34·7	29	Higher.
1853	35	32	32	25	20	14	27	20	24	28	38	39	27·8	25	High.
1854	39	39	38	38	27	24	25	27	36	44	48	50	36·2	26	Bel'w mean.
1855	52	53	36	40	40	36	34	36	36	34	33	33	38·6	20	" "
1856	35	35	33	31	23	18	23	30	37	46	53	53	34·7	35	Higher.
1857	54	56	46	44	35	24	19	12	14	9	24	22	30·0	47	High.
1858	19	13	13	18	4	6	4	2	8	12	14	16	10·9	17	Very high.
Means.	42	42	39	38	30	27	28	29	34	36	41	40	29·8	25	

Some results are obvious on the Table.

1. The summer months have higher water, for 10 of the 13 years. As this depends on the melted snows and spring rains over the greater watershed, the water is higher in the eastern of the lakes later in the season, affecting Lake Ontario after Lake Erie.

2. The winter months have the lower water for ten of the thirteen years. This is owing to the less water which falls over the section in the fall months and the greater evaporation through the preceding months.

The means of the months at the bottom of the table illustrate the general conclusion involved in these two results.

3. In 1848 the level was the lowest in November; in 1850 in November, and in 1856 equally low in November and December, from the less rains in the preceding months.

4. In 1848 the highest was in January; and in 1857 in October; and in 1855 in November, from preceding rains.

5. The lowest measured in these years was in February, 1857, and the highest in August, 1858, giving the range in the whole period to be 56−2=54 inches. [The maximum and minimum level was at Toronto in the same two months of these two years, and the range was the same, 54 inches. For this fact I am indebted to the intelligent and accurate observer at that port in Canada West, the Harbor Master. The range is found to be nearly the same in Lake Michigan.] These facts show that the common statements, in the summer of 1858, of the lake being some feet higher than before known or in many years, were utterly false. In 1858 the level was seven inches higher than in 1857.

6. There is no periodical rise and fall of the lake discernible on the table, and the variations in the level of the lake seem to be dependent on very regular and adequate causes of supply and drain.

7. Observation shows that the direction and force of the winds make the variations not altogether simultaneous at the ports having positions differently affected by the winds. Still a series of observations must lead to closely approximate results.

8. The table contains only the slow monthly and annual changes of the level. I have not introduced other measures, made in some other parts of this lake, on account of the impossibility of reducing them to the same zero, as there has been no standard, but different points have been assumed by observers. Neither have I noticed those sudden changes of the level, where the water falls or rises several feet in a few moments; and when the return wave causes the water to rise or fall alternately three to six feet. These alternations occur several times about twelve or fifteen minutes apart till the water comes to the previous level. Some of these are known to have been caused by violent winds or whirlwind tempests. Probably this is the uniform cause, as it is fully adequate to the effect.

Rochester, N. Y., March, 1859.

ART. XLVII.—*Contributions to Mineralogy*; by F. A. GENTH.

1. *Whitneyite, a new species.*

MASSIVE, structure crystalline, finely granular. H. =3·5. Sp. gr. at 16° Cels. =8·408. Lustre metallic; color reddish-white (about that of the new American cent, or of an alloy of equal quantities of copper and silver). Admits of a fine polish, but soon tarnishes, first assuming a yellowish hue, which gradually changes to brown and finally to brownish-black; sometimes iridescent. Somewhat malleable.

B.B. it fuses readily and gives off the odor of arsenic. Insoluble in chlorhydric acid; soluble in nitric acid. Composition: $Cu_{18}As$. Analyses:

			Calculated.
Copper,	88·07	88·19	88·37
Arsenic,	11·81	11·41	11·63
Silver, Insoluble,	0·33	0·47	
	100·21	100·07	100·00

The material for the analyses was selected with the greatest care and was apparently quite pure.

It occurs coated with red copper, and a copper-salt resulting from its oxydation, probably olivenite. One boulder of forty pounds in weight has been found at the Pewabic Mine, Houghton County, Mich., and was mistaken for silver. The material for the above analyses has been kindly presented to me by John F. Blandy, Esq., of Philadelphia. According to the information received from him, the agent of the Albion Mine recognizes the same mineral as occurring in a small vein of from three to four inches in width, and about one mile from the Cliff Mine, at the Albion location. I have named the mineral in honor of Professor J. D. Whitney, who informs me that a mineral, which he found at the Minnesota Mine, is identical with my new species.

In its chemical relations it is of considerable interest, because it is another example in which a multiple of six equivalents of copper combines with one of arsenic, forming with domeykite and algodonite a beautiful series of arsenids of copper, viz:

Domeykite, - - - -	Cu_6As.
Algodonite, - - - - - -	$Cu_{12}As$.
Whitneyite, - - - - -	$Cu_{18}As$.

(*To be continued.*)

Art. XLVIII.—*On Spontaneous Generation.*

1. *Remarks of Prof.* Milne Edwards *on the value of certain facts as evidence of the spontaneous generation of animals,* made before the Academy of Sciences at Paris,* at the session of January 3, 1859.

Physiologists have long been divided on the subject of the origin of life in organized beings. The larger part believe that this force exists only where it has been transmitted; that from the creation of the species till the present time, an uninterrupted chain of possessors of this power has communicated it successively; and that dead matter has no power of organizing a plant or an animal unless it be submitted to the action of a living being or a germ that has proceeded from an individual of some species.

Others, on the contrary, have held that inert matter, under certain chemical and physical conditions, could take on life without the agency of a generating being; that plants and animals may produce themselves in all their parts without deriving the principle of existence from another living body; and that consequently life itself must be considered, not as a force which has been imparted peculiarly to organized beings, but as a general property of organizable matter manifesting itself under certain favorable conditions.

In my lectures and writings, I have often combatted this last doctrine; and the hypothesis of *spontaneous generation* has to-day so few supporters among zoologists, that I should have feared to abuse the patience of the Academy in discussing it at this time, had I not seen in the Report of a recent session of this body, that one of our correspondents, Mr. Pouchet, had made it the object of new researches and had arrived at conclusions, which, if right, sustain the idea that living beings may be made by the same general forces on which chemical combinations in inorganic nature depend. Since reading this memoir, I have thought it might be useful to submit to the judgment of my colleagues my reasons for rejecting its conclusions; and it appears to me desirable also to know the opinions of other physiologists on a point of so much importance: besides, the question reaches beyond the domain of the natural sciences, and we may look for additional light from our chemists.

Long before the invention of the microscope had enabled zoologists to discover the animalcules which are produced in

* Comptes Rendus, 1859, p. 23. The Zoologists and other members of the Academy who have here expressed their views on spontaneous generation, are at the head of their respective sciences in France.

myriads in waters containing an infusion of organic matters, it had been observed that dead bodies when left to putrefy often became populated with swarms of life; and as the intervention of no living being was manifest in their production, the old naturalists supposed them a product of the putrefaction which was in progress, believing that the material, after ceasing to pertain to a living being, could reorganize itself under a new form and so constitute animals which had no parent; accordingly, that life is not the cause, but the consequence of a certain mode of arrangement of the molecules composing these substances, and that this kind of molecular grouping could be determined by inorganic forces in nature.

The occurrence of maggots in carrion was one of the cases. But since the study of the origin of these animals by the Florentine Academy, happily named "del Cimento," and the exact investigations of Redi, one of its members, it has been well understood that these worms about dead bodies, far from being a result of spontaneous generation, are the brood of well known insects, species which find in such bodies the conditions requisite for development, and hence, through a marvellous instinct, deposit there their eggs.

The experiments of Redi, which date from the middle of the 17th century, left no uncertainty respecting these larves. But while very easy to establish the fact respecting animals as large as flies, it was far less so with regard to infusory animalcules, which are discernible only by means of the microscope, and whose germs are so excessively minute that they have escaped all the methods of observation which the science of optics has supplied. When, therefore, Lewenhoek and his successors made known the existence of these animalcules, the hypothesis of spontaneous generation regained favor. While some physiologists regarded them as derived from germs of extreme minuteness which were spread every where in nature, and floating as fine dust in the atmosphere, settled on all bodies to develop only where the conditions of air, water and organic decomposition favored; others denied the existence of germs, and supposed that under the dissolving action of the water, the dead organic substance took on life and so came out as new beings.

Analogy afforded a strong argument for the first of these opinions. The second has often been sustained by appeals to researches claiming that animalcules were produced under circumstances in which all germs from external sources were excluded, and all present in the waters used had been destroyed. Frey and several other observers have thought that they had succeeded in securing these conditions and still had found their infusions populated with microscopic plants and animals; whence the conclusion that these organisms were a result of spontaneous generation.

It does not pertain to me to pronounce on the origin of microscopic plants, for this difficult subject must be left to botanists. But as regards animals, I do not hesitate to say that the experimental conditions required to prove the truth of spontaneous generation have not been realized by any of the predecessors of Mr. Pouchet. And are the researches of this naturalist, that have recently been communicated to the Academy, free from the objections which are made against earlier experiments? I believe not: and before mentioning some observations I have had occasion to make on this subject, I will briefly state the reasons that lead me to this conclusion.

I do not question the facts stated by Mr. Pouchet. The point is, Have these facts the significance attributed to them? I believe not. His experiment is briefly as follows. After having boiled some water and kept the liquid from contact with the air, he puts it into contact with pure oxygen, and introduces a certain quantity of hay, which had been previously enclosed in a flask and heated for a half hour in a stove whose heat was carried up to 100° C. or to the boiling point of water. The infusion thus prepared was hermetically sealed, and after some days Mr. Pouchet found infusoria developed in it.*

To make these facts sure proof that the animalcules obtained were not derived from the hay put into the infusion, it must be shown that the heat of the stove had destroyed all the germs. Mr. Pouchet presumes that this is true, because on boiling in water the spores of a *Penecillum* he has seen that they were decomposed. But this reason does not satisfy me.

In the first place, was the hay, although enclosed in a flask and kept thirty minutes in a stove at 100° C. (212° F.), really carried up to the temperature of boiling water? Mr. Pouchet believes it; but I think to the contrary, and I think that physicists and chemists will judge so too. The equilibrium of temperature under such conditions is not established so promptly as this; it appears to me probable that the hay, enclosed in a glass vessel and surrounded by air in repose, both substances bad conductors of heat, was in reality heated but little by the heat of the stove during the short time it was exposed to it.

But supposing that the hay was heated up to 100° C., can we then conclude that the germs had lost their vitality and were incapable of development? No, for there is an important distinction here to be recognized between the action of heat on organized bodies which contain water and on those which are in the dry state. This follows directly from the researches, already old, of our learned colleague, Mr. Chevreul. Although in ordinary circumstances death takes place when animals are exposed to a

* See page 253 of this volume.

temperature sufficient to determine the coagulation of the hydrated albumen in their tissues, we know that this is not always so in the case of those which have been previously dried. In fact, fifteen years since, Mr. Doyère made known that certain animalcules, such as the *Tardigrades*,* after being sufficiently dried would preserve their vitality for several hours while exposed in a stove whose temperature is much higher than that used by Mr. Pouchet for his flask of hay. I have seen these animalcules resist thus the very prolonged action of a stove whose temperature stood at 120° Centigrade (248° F.); and in the researches of Mr. Doyère, the heat of the ambiant medium was carried to 140° C. (284° F.) without death ensuing from the heat.

What is true for the *Tardigrades*, animals of a very complex structure, may also be true for the germs of Infusoria in general; and I conclude that nothing in the trials of Mr. Pouchet authorizes us to infer that the germs of the animalcules obtained by this naturalist were not in the hay that was used in his experiment. I will even say that the experiments of our correspondent do not seem to me to add any new probability in favor of the hypothesis of spontaneous generation.

I have often made analogous experiments; and I have always found that the living animalcules which appeared in water containing dead organic matters, were increasingly rare the more complete the precautions employed for protecting the liquids from the introduction of germs. In more than one trial, I should have believed that spontaneous generation had taken place under my own eye, had I not, on reflecting on the conditions under which I was operating, perceived sources of error, and on setting these aside, observed negative results to multiply.

I will not occupy the Academy with the general recital of these trials, but will ask permission to recount briefly a single series of experiments in which some infusions, that if exposed to the air would in all probability have given birth to animalcules, afforded none when the imprisoned matters in the hermetically sealed vessel had been subjected to a temperature high enough to cause the coagulation of the contained albuminoid substances.

I placed in two tubes, having the form of test-tubes, the water and the organic matters for the trial. One of these tubes, which was two-thirds filled with air, was then closed by means of a lamp, and both this and the other tube were then plunged into a bath of boiling water. The bath was kept in ebullition long enough to establish an equilibrium between the water outside

* The Tardigrade animalcules are minute worm-shape animals about a fortieth of an inch in length, belonging to the Rotatoria of Ehrenberg, and therefore much higher in structure than the ordinary Infusoria.

and the liquid of the two infusions; and then the tubes were allowed to cool and left to themselves, care being taken to examine the contents from time to time. After some days, I found animalcules in the tube which remained open to the atmosphere, but *not a single one in that which had been hermetically sealed.*

I have been accustomed to cite these experiments in my lectures, but had not thought of bringing them before the Academy, because negative results acquire importance only when they have been obtained constantly in a large number of trials, and also because the spontaneous generation of animals appears to me so little probable that I would not devote time to the repetition of researches on a subject which seems to be already settled. Only in view of the communication of our correspondent, and the interest that experimenting in this direction may excite in our young physiologists, have I been induced to bring out these facts among the reasons for still rejecting the hypothesis of spontaneous generation as an explanation of facts connected with the multiplication of animalcules.

An hypothesis which is not necessary in order to understand the phenomena made known by observations, and which is in flagrant discordance with all that analogy teaches us, seems to have no right to a place in science. It may be that chemistry will be able to make all the kinds of substances which occur in the constitution of living bodies; but as to the genesis of living organisms without the concurrence of vital force, I see no reason for believing it. Until more amply instructed, I shall therefore continue to think that in the animal kingdom there is no such thing as spontaneous generation, and that all animals, large and small, are subject to the same law, and can exist only when they have been generated by living beings.

2. *Remarks on the same occasion*, by Mr. PAYEN, Professor in the Conservatoire Imperial des Arts et Metiers.

Some time in 1843, there occurred an alteration of the bread at Paris by a rapid growth of cryptogamic vegetation; and after having determined in connection with Mr. Mirbel the cause of the phenomenon, which had produced some excited dissatisfaction among the people, I endeavored to determine the temperature at which the sporules of the *Oidium aurantiacum* lost their germinative power. These sporules were heated at first for an hour to 100° C. (212° F.) in a tube inserted in an oil-bath. A part were then withdrawn and exposed in the proper circumstances for growth; and germination took place. The remainder of the sporules were then heated to 120° C.; and they neither underwent change of color nor lost their property of germination. Finally, they were heated to 140° C., when their appearance

was altered, the color became reddish-orange in place of brownish-yellow, and the germinative power was destroyed.

These results sustain, as regards the lower orders of vegetation, the opinion expressed by Prof. Milne Edwards respecting animalcules.

3. *Remarks on the same occasion*, by A. de Quatrefages.

I have often expressed on the subject of spontaneous generation similar opinions to those of Milne Edwards; and I now give my full adhesion to the conclusions of my learned associate. I take the floor only to communicate to the Academy an observation, which, although incomplete, confirms ideas now generally admitted. [De Quatrefages adds some facts sustaining his opinion.]

4. *Remarks on the same occasion*, by Dr. Claude Bernard.

Among a large number of experiments which I have made to ascertain the influence of saccharine substances in liquids where microscopic vegetation was developed, I will cite one, as it bears directly on this subject of spontaneous generation now under discussion.

On the 1st of September, 1857, I put into two glass flasks, each half a litre in capacity, about fifty cubic centimeters of a same dilute solution of gelatine in water to which some thousandths of cane-sugar had been added. The liquid was then kept boiling in the two flasks for a quarter of an hour, the tubular neck of each having been previously drawn out so that it could easily be sealed. Up to this point there was no difference between the flasks. Now, when the flasks were still boiling and filled with steam, a difference was begun by allowing ordinary air to enter one, and highly heated air the other. To accomplish this, while ebullition was going on, the neck of one of the flasks was connected with one of the extremities of a porcelain tube filled with fragments of porcelain and brought up to a red heat by a furnace; at the other extremity the porcelain tube was terminated in a glass tube of fine bore, so that the air should enter gradually and pass very slowly over the red-hot porcelain. Thus situated, the vapor of the liquid in ebullition rose into and filled the porcelain tube, and even passed out at the end of the fine tube. The lamp was then removed to arrest the ebullition; and by degrees the steam was condensed and the outside air (air of the laboratory) entered to take its place, passing through the red-hot porcelain tube above described. After the liquid had cooled, the flask was hermetically sealed at the neck.

The other flask was allowed to cool without any connection with the porcelain tube, and the atmospheric air entered freely. When the flask was cooled it was sealed like the other.

The two flasks were then placed in the same conditions, exposed to the light and to the ordinary temperature. After ten or twelve days, at the surface of the flask containing the ordinary air, vegetation was visible, a well-characterized mould, whilst in that which had received the heated air the liquid remained perfectly limpid, and without any thing on its surface. After a month the mould had much increased in the former, while nothing had appeared in the latter, except that the water had slightly lost its clearness. After six months (March 4, 1858) the mould remained stationary in the former, while in the other the liquid continued the same, without any trace of mould.

The extremities of the two flasks were now broken under mercury. In the case of the one with heated air, considerable mercury was absorbed, but none in the other. The air of the two flasks being analyzed, no oxygen was found in either. The air from the flask with ordinary air contained 13·48 per cent of carbonic acid, that of the other, in which no mould had formed, 12·43 per cent.

The liquid of the flask with ordinary air had a putrid and very disagreeable odor, while the other had none. These liquids were examined by Mr. Montagne; and our Associate ascertained that the mould developed in the flask with ordinary air was the *Penecillum glaucum*, which was in full fructification; in the other he found no trace of any vegetable or animal organism.

It is plain that this experiment, like those which have been before cited, is not favorable to the hypothesis of spontaneous generation.

5. *Remarks on the same occasion and subject by the chemist* DUMAS.

Dumas stated that he was in full agreement with his honorable Associates. For thirty years he had had under careful examination the question on which Prof. Milne Edwards had instructed the Academy with so high authority, and he had arrived at precisely the same conclusions.

He was incited to experiment on the subject by the publication of Mr. Frey, who had announced results analogous to those communicated to the Academy by Mr. Pouchet.

In his experiments he has assured himself that organized matters heated to 120° C. or 130° C. with water artificially made by means of hydrogen and oxyd of copper, and with artificial air in closed tubes, the glass of which had been recently heated to a red heat, produced neither vegetation nor animalcules. On opening these tubes and allowing ordinary air to enter, there was soon an appearance of vegetation and animalcules. These results had surprised him, as he was disposed to think that the germs of these plants and animalcules might be distributed in

the organized matter as well as in the air itself, and that certain of these germs might well be of a nature to resist a temperature of 100° C. or even a higher temperature.

As the Tardigrades when absolutely dry resist 140° C., and the sporules of *Oidium aurantiacum* 100° C. in a moist medium, it will not suffice in order to establish the hypothesis of spontaneous generation, that living beings should sometimes appear in boiling water in contact with artificial air and with the presence of organic matters that had before been heated, especially if these matters were heated when dry. When among these inferior animals and plants, life is suspended by absolute desiccation to return to action again on a return of humidity, the being so treated is in that state of latent animation which belongs to germs. It is hence a matter of astonishment that on putting heated organic matters into connection with oxygen and artificial water, we do not sometimes find living beings to appear. Even such an observation as this, would not therefore suffice to establish the theory of spontaneous generation, or prove that the germs of these beings were not previously deposited in the organic matters employed. But, in fact, whilst animalcules appear when the ordinary air has access, without this access under the precautions mentioned they do not appear.

6. *Note on Spontaneous Generation*, by JAMES D. DANA.

1. There is a well-known principle in the system of nature that deserves to be considered in this connection. The principle is so fully sustained by all research both in chemistry and zoology, including the important experiments above mentioned, that it may well carry with it great weight, and quiet both apprehension and expectation on this subject. It is this:—The forces in life and inorganic nature act in opposite directions, the former *upward*, the latter *downward.*

The vital force, in the organic substances it forms, *ascends* through vegetable and animal life to an exalted height in the scale of compounds at an extreme remove from saturation with oxygen; inorganic force *descends* towards the saturated oxyd. The former reaches a point which from its very elevation is one of great *instability;* the latter tends towards one of perfect *stability.* There is hence a counterpart or cyclical relation between the two great lines of action in nature.

As some readers of these remarks may not be familiar with chemistry, a further word of explanation is added.

When an element unites with its full allowance of oxygen, as determined by its affinities, it is in a sense saturated with it. Since the attraction of the elements for oxygen is the most universal and, in general, the strongest in nature, the oxyds as a

class are the most stable of compounds; the rocks, the earth's foundations, are made of them. But evanescence and unceasing change are in the fundamental idea of the living structure; and consequently the material of the plant or animal contains only oxygen enough to give increased instability to the combination. Moreover the compounds augment in instability, through this and other ways, with the rise in the grade of organic life, and reach probably their farthest extreme in this respect in the brain. Here then is the summit of the series of compounds which arise under the agency of life. The stable oxyd is at the lower end of the series in nature, the material of the brain at the upper. Passing from the latter condition towards the former is therefore a real descent; and it is the natural downward course of inorganic forces;—while passing towards the latter is as truly an ascent; it is the counter-movement of life.

The plant through its vital functions may take carbonic acid, and from it, continue to elaborate the organic products constituting vegetable fibre, until a whole tree of such material is made, and then produce the higher material of the flower and seed. The animal may then go to the plants and use them in making a still higher class of products, muscular fibre and nerve. After all this is done, now turn over the material to the action of chemical and physical forces,—and the work of years of life is soon pulled down from its height, and one part after another descends towards that state of comparative inactivity, the condition of an oxyd. Chemistry makes organic products by commencing with those of a higher grade than the kind to be made, but not otherwise. Albumen is a prominent material of the egg; and chemistry has not succeeded in making dead albumen, much less living.

The very relation of life to chemistry is therefore evidence that chemistry cannot make life; it works in just the reverse direction. And in this reciprocal relation one of the profoundest laws of nature is exhibited. It leads the mind to recognize one author for both, and not to imagine that one side in the cycle has generated the other.

2. There is another consideration, which, if it has not the force of demonstration, may help the mind to understand the extent of the transition from dead matter to living.

(*a*) In ordinary *inorganic* composition, there is the simple formation of inorganic particles, and, on consolidation, their aggregation into crystals, the perfect individuals of inorganic nature. With the enlargement of the crystal there is no gain of new powers or qualities: it simply exists. In fact, in entering this state of perfection, there is *a loss of latent force;* for the gas is the highest condition of stored or magazined force in inorganic

nature, the liquid the next, and the solid the lowest, this condition of power being related directly to the amount of heat.

(*b*) The *plant* grows from its germ, enlarges, accumulates force storing it away in vegetable fibre, and accomplishes its highest functions in its blossoms and fruit. But there is here only *latent or stored force* generated, besides that which is used up in growth, and *no mechanical* force. The minute spore or reproductive cellule of some seaweeds has locomotive power, but it is lost at the commencement of germination; and the plant is ever after as incapable of self-locomotion as a rock.

(*c*) In the *animal*, there is not only a storing of force in animal products (the fifth and highest grade of stored force in nature), but there is also increasing *mechanical* force from the first beginning of development. It is almost or quite zero in the germ; but from this, it goes on increasing until in the horse, it gets to be a one-horse power; or in the ant, a one-ant power; and so for each species. And in addition to mechanical force, there is, in the higher group, the more exalted *mental force;* for the mind, while not itself material, is yet so dependent on the material, that its action draws deeply upon the energies of the body. To make an animal germ is then to make a particle of albuminoid substance that will grow and spontaneously develop a powerful piece of enginery, and continue a system of such generations through ages of reproduction.

The creation of any such animal germ out of dead carbon, nitrogen, hydrogen and oxygen, or any of their dead compounds, is therefore opposed to all known action or law of chemical forces; and as much so, the creation of a vegetable germ from inorganic elements.

Moreover, it is seen that the two kingdoms, the vegetable and animal, have their specific limits and comprehensive reciprocal relations, and are obviously embraced as parts of one idea in a single primal plan:—not a plan involving the generation of one out of the other, or of either out of inorganic nature, but of the three, through some Creating Power higher than all.

Art. XLIX.—*Eruption of Mauna Loa, Hawaii.**

The central crater of Mauna Loa is again in action. According to a letter from the Rev. T. Coan of Hilo and the public papers, the eruption began on Sunday the 23d of January last.

This is the fourth great eruption since the beginning of the year 1843. Previous to that time *Kilauea*, the still more spacious crater on the eastern slopes of the mountain, had been often in violent action, while the summit crater was quiet, and

had long so remained. The account of boiling fires in the pit at the summit, brought down by the unfortunate Douglas in the year 1834 was disbelieved, because of the accustomed quiet of the crater, in addition to some evident exaggerations in his description and the absence of any manifestations of fires distinguishable from the foot of the mountain.*

Kilauea discharged its lavas through the sides of the mountain in 1823, June 1832, and June 1840. The lower pit, which was 400 feet deep after the eruption of 1840, had filled up again by 1848, and the bottom had become raised by the overflows of the pool even above the level of the old black ledge. In the course of these changes a broad dome was raised over the site of the great lake of boiling lavas in the southwestern extremity of the crater; in a basin at the centre of the dome the lavas were still smoking, and boiling or subsiding with its varying phases. Eleven years have since passed, and Kilauea has had no new eruption. Mr. Coan in his recent letter (Feb. 3, 1859,) observes:

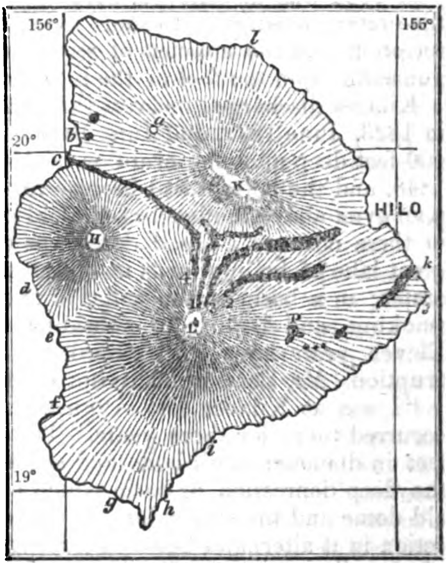
"I was at Kilauea last August. No striking changes have occurred there for three years. The great lake now some 500 feet in diameter—still boils and sputters lazily in the centre of the deep depression or basin which occupies the locality of the old dome and the still older lake of far larger dimensions. The action in it alternates between a refrigeration and a breaking up of the whole surface with intense ebullition. Mr. Sleeper of Charlestown, tells me that during a recent visit to this pool he saw it throw up jets of fire 100 feet high."

After the last eruption of Kilauea, the action of the central crater of Mauna Loa (called Mokua-weo-weo) began to revive. In January 1843 there was an outflow which commenced at a height of 13,000 feet, and extended on for 25 or 30 miles running northward toward Mauna Kea, and part northwestward. It is No. 1 in the annexed map. Again on the 17th of February, 1852, another eruption (No. 2,) took place, making its first appearance near the summit, but after three days, beginning its principal outflow from a point 10,000 feet above the sea, where there was a fountain of lava 1000 feet in diameter and 300 to 700 feet high described by Messrs Coan, Fuller, and others (this Journal, [2], xiv, 219, 254, xv, 63). It flowed off to the eastward with a winding course for about 40 miles. In August 1st, 1855, a third eruption (No. 3 on the map) took place, beginning at a height of about 12000 feet, according to Mr. Coan, and continu-

* This word foot, although correctly used, is sure to convey a wrong impression unless it is remembered that Mauna Loa has a breadth of 50 miles, and a height of only 2¾ miles. By laying off an equilateral triangle having the base 20 times the height, and then rounding a little the top, an approximate section will be obtained. It will be improved by extending the eastern slope one fourth farther at an angle diminishing gradually to one degree. The crater Kilauea is but 3,970 feet above the sea, although 18 to 30 miles from the coast.

ing its progress for a year and a half, it stopped within five miles of Hilo. (This Journal, xxi, 100, 139, 237, 241, xxii, 240, xxiii, 435).

Finally, on the 23d of last January, according to Mr. Coan, a fourth great outflow commenced: making three eruptions at intervals of 3½ years, and four from January, 1843. Mauna Loa is hence quite taking the lead in activity among the earth's larger volcanoes. And as Kilauea has remained quiet since the older crater began its outbreaks, it would seem as if the mountain had transferred to the latter its principal activity. Yet according to all reports, hitherto, Kilauea, although the larger crater and an open vent at a level 10,000 feet lower, has shown no signs of sympathy in its lavas with the violent action at the summit.



ISLAND OF HAWAII.

L, Mauna Loa; K, Mauna Kea; H, Mauna Hualalai; P, Kilauea or Lua-Pele; 1, Eruption of 1843; 2, of 1852; 3, of 1855; 4, of 1859; *a*, Waimea; *b*, Kawaihae; *c*, Wainanalii; *d*, Kailua; *e*, Kealakekua; *f*, Kaulanamauna; *g*, Kailiki; *h*, Waiohinu; *i*, Honuapo; *j*, Kapoho; *k*, Nanawale; *l*, Waipio. The courses of the currents, excepting that of No. 4, are from a manuscript map by Mr. Coan.

From the letter of Mr. Coan and the notices in the public paper of Honolulu referred to, we derive the following accounts of the recent eruption. It has yet been but imperfectly explored.

The editorial writer in the "Commercial Advertiser" of Honolulu, in his visit to the region, reached the central plain of the island between Mauna Loa, M. Kea and Hualalai, elevated about 4000 feet above the sea. He says:

"This new crater, for which we can find no native name except '*Pele hou*,' (the new eruption,) is located on the northern slope of Mauna Loa, at an elevation of, say 6,500 feet, above the sea, and at an equal distance below the level of the summit of the mountain. It is some ten miles or so more to the westward, and about 4000 feet lower down, than the last eruption of 1855. The course of the stream, from its source to the sea, we judge to be nearly N. W. by N. The crater bears due east from Kailua by the compass, and is about 24 miles from that harbor in a straight line. Its latitude, as near as we are able to determine without instruments, is 19° 37′, and the longitude 155° 40′.

From the distance at which we observed the crater, about ten miles, and from various points of observation, it *appeared* to be circular, its width being about equal to its breadth, and perhaps 300 feet across the mouth. This may be too moderate an estimate, and it may prove to be 500 or even 800 feet across it. The rim of the crater is surrounded or made up of cones formed from the stones and scoria thrown out. The lava does not simply run out from the side of the crater like water from the side of a bowl, but is thrown up in continuous columns, very much like the Geyser springs, as represented in school geographies. At times this spouting appeared to be feeble, rising but little above the rim of the crater, but generally, as if eager to escape from the pent-up bowels of the earth, it rose to a height nearly equal to the base of the crater. But the columns and masses of lava thrown out were ever varying in form and height. Sometimes, when very active, a spire or cone of lava would shoot up like a rocket or in the form of a huge pyramid to a height nearly double the base of the crater. If the mouth of the crater is five hundred feet across, the perpendicular column must be eight hundred to one thousand feet in height! Then by watching it with a spyglass, the columns could be seen to diverge and fall in all manner of shapes, like a beautiful fountain.

This part of the scene was of wonderful grandeur. The fiery redness of the molten lava, ever varying its form, from the simple gurgling of a spring to the hugest fountain conceivable, is a scene that will remain on the memory of the observer till death. Large masses of red-hot lava, weighing hundreds if not thousands of tons, thrown up with inconceivable power to a great height, could be seen occasionally falling outside or on the rim of the crater, tumbling down the cones and rolling over the precipice, remaining brilliant for a few moments, then becoming cold and black, and lost among the surrounding blocks of lava.

A dense heavy column of smoke continually rose out from the crater, but always on the north side and took a northeasterly direction, rising in one continuous column far above the mountain, to a height of perhaps 10,000 feet from the crater.

On leaving the crater, the lava stream does not appear at the surface for some distance, say an eighth of a mile, as it has cut its way through a deep ravine or gulch, which hides it from the eye. How deep this gulch may be is all conjecture, as it is impossible to get near enough to look into it, but it probably is several hundred feet deep. The first then that we see of the lava after being thrown up in the crater is its branching out into various streams some distance below the fountain head. Instead of running in one large stream, it parts and divides into a great number, spreading out over a tract of five or six miles in width. For the first six miles from the crater, the descent is rapid, and

the flow of the lava varies from four to ten miles an hour, according to the descent. But after it reaches the plain, where it is level, the stream moves more slowly. Here the streams are not so numerous as higher up, there being a principal one which varies and is very irregular, from an eighth to half a mile in width, though there are frequent branches running off from it. This principal stream reached the sea near Wainanalii, or about fifteen miles south of Kawaihae, on the 31st, after a flow of eight days from the time that the eruption commenced on the 23d of January. This stream, on reaching the sea, spread out to about half a mile in width, and clouds of steam rose several hundred feet high, and covered the region.

The length of the lava stream from the crater to where it enters the sea at Wainanalii, we estimate to be thirty-eight miles. For the first ten miles from the crater, the flow is divided into many streams—perhaps as many as fifty—but lower down, it is confined to one or two principal streams with frequent branches to the right and left."

Another writer in the same paper, L. Lyons, dating Waimea, Feb. 4, makes the important statement that an outbreak took place first "very near the top of the mountain," and that the outflow at 6500 feet was only a continuation of the eruption.

"On Sabbath, Jan. 23d, volcanic smoke was seen gathering on Mauna Loa. In the evening the mountain presented a grand yet fearful spectacle. Two streams of fire were issuing from two different sources, and flowing, apparently, in two different directions. The whole region, earth and heaven, were lighted up, and even the interior of our houses received the lurid volcanic light direct from its source. In the morning of the second day, we could discern where the eruptions were. One appeared to be very near the top of the mountain, but its stream and smoke soon after disappeared. The other was on the north side, further below the top, and was sending out its fires in a northwesterly direction. On the second and third nights, the dense smoke and clouds prevented us from a fair view of the action: but on the four following nights we had a view—and such a scene! It seemed as though the eye could never weary in gazing at it. The burning crater seemed to be constantly enlarging and throwing up its volumes of liquid fire above the mouth of the crater—I will not venture to say how high—and the fiery stream rolled onward and onward, still adding grandeur and terror as it proceeded, till, on the morning of the 31st, about sunrise, the stream was compelled, though reluctantly, to stop, by meeting the waters of the ocean. Even then its resistless and opposing energy carried it on some distance into the sea. The poor inhabitants of Wainanalii, the name of the village where the fire reached the ocean, were aroused at the midnight

hour by the hissing and roaring of the approaching fire, and had but just time to save themselves. Some of the houses of the inland portion of the village were partly surrounded before the inmates were aware of their danger. Wainanalii is near the northern boundary of North Kona, and about twelve or fourteen miles from Kawaihae. It is, of course, all destroyed, and its pleasant little harbor filled up with lava. The volcanic stream was one mile wide or more in some places, and much less in others. It crossed the Kona road and interrupted the mail communication. The whole distance of the flow from the crater to the sea is some forty miles.

Last night (the 3d Feb.) the volcano was in full blast, and the burning stream seems to have taken another direction."

Mr. Coan writes from Hilo on Feb. 3, having projected but not yet undertaken a journey of exploration.

"On the 23d ult. Mauna Loa opened near its summit and out rushed a flood of lavas, which made unusually rapid progress in its descent. So vigorous was the action and so immense the floods of lava poured out, that, for a long time, there seemed no blackening and refrigerating process on the surface, but a vast incandescent river rushing madly down and throwing up such an intense glare as appeared like a consuming mountain and a burning firmament. The course of the stream was north, until it was diverted by the base of Mauna Kea, when it turned west-northwest and flowed towards the opposite coast of our island. So great has been the light and so vehement the action, that many pronounce it the greatest eruption we have ever had in so short a time.

At the present time there is no light and but little smoke visible from Hilo at the summit or side of the mountain, but the light is still intense all over the isthmus between the mountains.

The present eruption commenced very near the point of the one in 1843 [at the summit] which cost me such fatigue and danger in exploring. The direction of the lava stream or streams is, also, very nearly the same."

This eruption appears to have been similar to that of 1855 in its jet or fountain of lavas at the great outbreak. The first outbreak at the summit shows that the column of lavas of Mauna Loa had the height of about 13,000 feet, or 9500 above the level of the bottom of the crater of Kilauea. The second outbreak at a height of 6500 feet, was therefore 6500 feet below the first; and it proves that a column of 6500 feet of heavy liquid lavas was acting by its pressure in producing the fountain of lavas described. Like all the preceding eruptions of the grand old mountain, there were no great shakings or subterranean sounds, so common in the more blustering action of little Vesuvius. There is rock material enough in Mauna Loa to make *one hundred and twenty-five* Vesuviuses. J. D. D.

SCIENTIFIC INTELLIGENCE.

I. PHYSICS AND CHEMISTRY.

1. *Researches on the Thermic action of the Solar Spectrum.*—Müller has communicated an interesting memoir upon the subject of the thermic action of the solar spectrum, a subject which has hitherto attracted comparatively little attention. In his introduction, the author in the first place, briefly reviews the experiments of Melloni, who confined his attention almost exclusively, to the determination of the position of the maximum temperature in the spectrum. Experimenting with a prism of rock salt, Melloni found the maximum of heat in a position which lies about as far outside the red limit of the spectrum as the place of passage from the green to the blue is distant from the red end. The Italian physicist gave however no numerical data from which the thermic curve in the spectrum could be deduced. Melloni also, who had previously adopted the opposite view, afterward maintained the perfect identity of rays of light and heat of the same degree of refrangibility. This last view as to the identity, was also adopted by Masson and Jamin, who found that all the rays of heat which lie within the visible spectrum are equally well transmitted by rock salt, rock crystal, alum, glass, etc. That consequently the unequal transcalency of these substances is only occasioned by their unequal capacity of absolving the rays of heat which are less refrangible than the red. They have not however, published the details of their experiments.

The merit of first communicating measurements of the temperature at different points of the spectrum, obtained by means of the thermoelectric battery belongs to Franz. He found that in a spectrum which is pure enough to exhibit Fraunhofer's lines, the thermic effects are so slight that measurements are out of the question. As Franz' numerical data were obtained by means of a flint glass prism, which absorbs a considerable number of dark rays of heat, the curve of intensity, constructed upon his numbers, does not correspond to the distribution in a complete heat spectrum. This can only be obtained by means of a prism of rock salt. The instruments employed by Müller, consisted of a thermo-electric pile of 40· pairs of bismuth and antimony, of a multiplier of 3700· windings, and of a linear thermo-electric pile of 15· pairs. The sun's rays with which he experimented, were introduced into a dark room, by means of a Silbermann's heliostat.

Before undertaking experiments on the distribution of heat in the spectrum, the author endeavored to attain his object by investigating the absorbing action of colored liquids upon the rays of heat. This method requires us to assume the identity of rays of light and heat of the same degree of refrangibility. The liquids employed were enclosed between parallel glass plates, and optically analysed by means of a prism. They consisted of pure water, a solution of cochineal, a solution of bichromate of potash, a solution of chlorid of copper and a solution of ammonia sulphate of copper.

By directly comparing the quantity of heat transmitted through these liquids, with the character of the light also transmitted, the author found that the heating power of the less refrangible rays of the solar spectrum, namely of the red, orange and yellow rays, is much greater than that of the green, blue, indigo and violet.

After some preliminary experiments with a glass prism, the author proceeded to use a prism of rock salt, with the linear thermo-electric battery. From the numerical data obtained, he constructed the curves of thermic intensity in prisms of crown-glass, and of rock salt. This curve shows that the dark rays of heat in the spectrum, beyond the red, occupy, in the case of crown-glass, a space which is almost as long as the entire visible spectrum, and this result corresponds nearly with those of Franz. In the spectrum obtained by means of a prism of rock salt, the thermic maximum lies still farther outside of the red, than in the case of the spectrum with the glass prism, and the actual distance corresponds with the measurements of Melloni above mentioned. The dark thermic prolongation of the spectrum is, according to these experiments not greater for rock salt than for glass.

The above experiments show that the dark rays of heat which are contained in the solar spectrum, extend far beyond the red limit of the visible rays, and that for a crown-glass spectrum, Fraunhofer's line B lies about in the middle between the violet end of the spectrum and the extreme dark rays of heat. And since the index of refraction of crown-glass for the line H is about 1·546 and for B about 1·526, it follows that the index of refraction of the extreme dark rays of heat in the solar spectrum, is about 1·506.

The results of the author's experiments, as we shall see farther on, do not agree with Cauchy's formula for dispersion, which is intended to express the relation between the wave length and the index of refraction. This relation the author endeavors to express by an empirical formula of the form

$$w = a + be + ce^2 \quad . \quad . \quad . \quad . \quad (1.)$$

in which w represents the wave length, e the index of refraction, and a, b and c constants determined by experiment. This formula gives for the wave length of the extreme rays of heat in the solar spectrum and for an index of refraction of 1·506, the value

$$w = 0{\cdot}00177^{\text{mm}}.$$

The same result very nearly is obtained by a graphical construction, which gives

$$w = 0{\cdot}0019^{\text{mm}}.$$

The author takes the mean of these two determinations, namely,

$$w = 0{\cdot}00183^{\text{mm}},$$

as the wave length of the extreme dark rays.

The wave length of the extreme fluorescent rays in the sun's light is, according to Esselbach's experiments, 0·0003.

The wave length 0·0006, corresponding to Fraunhofer's line D in the orange, is the next lower octave of these most refrangible rays.

The second lower octave with a wave length 0·0012 falls in the middle of the dark rays of heat of the solar spectrum.

The third lower octave with a wave length 0·0024 falls outside of the limit of least refrangibility.

In all therefore the solar spectrum embraces somewhat more than two and a half octaves.

In conclusion, the author investigated the distribution of heat in the diffraction spectrum, the apparatus employed being a ruled surface of smoked glass (*Russgitter*), similar to that employed by Eisenlohr, and a linear thermo-electric battery of fifteen pairs, but found the thermic effects so small that he was obliged to abandon the hope of obtaining reliable results in this manner. He however deduces the curve of distribution of the heat in the diffraction spectrum from that of the refraction spectrum. From this curve, it appears that in the diffraction spectrum the dark rays of heat occupy a space which is about three and a half times as broad as the whole visible spectrum.

In a second memoir, the author returns to the subject of the disagreement of his experiments with Cauchy's formula for dispersion above alluded to. If n represents the index of refraction for a particular ray, λ the corresponding wave length, Cauchy's formula for dispersion is

$$\frac{1}{n^2}=a+\frac{c}{\lambda^2} \qquad (1.)$$

neglecting the higher powers of $\frac{1}{\lambda}$.

If we substitute in this equation the values $\lambda=0{\cdot}000396$ for the line H, and $n=1{\cdot}546$ for crown-glass, we have

$$0{\cdot}41839=a+c.6376900. \qquad (2.)$$

If we substitute the value $\lambda=0{\cdot}00069$ for the line B and $n=1{\cdot}546$ we have

$$0{\cdot}42943=a+c.2100400. \qquad (3.)$$

By combining these two equations we find

$$a=0{\cdot}43436$$
$$c=-0{\cdot}0000000023477,$$

and substituting these values in equation (1.) we have

$$\frac{1}{n^2}=0{\cdot}43436-\frac{0{\cdot}0000000023477}{\lambda^2}. \qquad (4.)$$

This is Cauchy's formula for the special case that n represents the index of refraction for crown-glass, and λ the corresponding wave length in the air. For $\lambda=\infty$ we have

$$\frac{1}{n^2}=0{\cdot}43436 \text{ or } n=1{\cdot}516,$$

and this is the least value of the index of refraction which is possible according to Cauchy's formula. Hence it appears that according to Cauchy's formula when the index of refraction diminishes from 1·546 to 1·526, the wave length diminishes from $0{\cdot}000396^{mm}$ to $0{\cdot}00069^{mm}$; when however the index diminishes from 1·526 to 1·517 the corresponding wave length ought, according to the formula, to increase from 0·00069 to infinity, a result which to say the least is extremely improbable.

For all values *less* than 1·517 and therefore for 1·506, equation (4.) gives imaginary values for λ. But by taking into consideration the influence which the ponderable particles exert upon the atoms of the ether which was neglected by Cauchy, Redtenbacher develops the formula

$$\frac{1}{n^2}=a+b\lambda^2+\frac{c}{\lambda^2}\cdots \qquad (5.)$$

This formula agrees with observation very well within the limits of the visible spectrum. When applied to Müller's index of refraction 1·506 for the extreme heat rays it gives for the corresponding wave length λ the value 0·0048^{mm}, which is more than twice as great as that above determined by the author. Müller remarks that this difference is not surprising when we consider how uncertain is the application of empirical formulas far beyond the limits for which their coefficients are determined. In any event the value $\lambda=0{\cdot}0048^{mm}$ is much nearer the truth than that deduced from the purely empirical formula. If we adopt this determination, 0·0048^{mm} for the wave length of the extreme dark rays of heat, we find that the entire solar spectrum embraces four complete octaves, of which not quite one is made up of the visible spectrum.—*Pogg. Ann.*, cv, 337, 543. W. G.

2. *On the Preparation of Chromate of Lead, for use in Elementary Analyses;* by Dr. H. Vohl, (Liebig's Annalen, April 1858, p. 127, cited from Chem. Gazette, No. 380, p. 319).—The employment of chromate of lead in elementary analyses, in which it has many advantages over peroxyd of copper, is considerably limited, partly by its cost, and partly by its troublesome preparation; moreover, it could not hitherto be restored to its original condition like oxyd of copper which has been used, so that after it has served twice or at the utmost three times, it has become completely useless. The behavior of the nitrates to oxyd of chromium at a red heat, led the author to examine into the action of nitrate of lead upon the oxyd of chromium. He mixed together one equivalent of each substance in fine powder, and heated the mixture in a porcelain crucible over the spirit-lamp. A considerable reaction very soon took place. The mass caked together, and a great quantity of nitrous acid was evolved. When the evolution of gas had ceased and the mass was more strongly heated, it fused, and on cooling furnished a radiately crystalline body of a dark reddish-brown color, which, when triturated, gave a brownish-yellow powder, and proved to be pure chromate of lead. When this salt is employed in elementary analyses, it is principally only the chromic acid that is deprived of its oxygen; and used chromate of lead may be again converted into the pure salt by moistening it with nitric acid and afterwards calcining it.

3. *On the Solubility of Sulphate of Strontia in Nitric Acid, Muriatic Acid, and Acetic Acid;* by R. Fresenius, (Liebig's Annalen, May, 1858, p. 220, cited from Chem. Gazette, No. 381, p. 338).—According to the author's previous experiments, 1 part of sulphate of strontia dissolves in 11,000 to 12,000 parts of water containing a little muriatic and sulphuric acid, that is, in a fluid such as is obtained when chlorid of strontium is dissolved in water and the strontia is precipitated by an excess of sulphuric acid. Sulphate of strontia is, however, unequally soluble in fluids containing a somewhat larger amount of nitric acid, muriatic acid, and even acetic acid. This must be taken into consideration in analyses.

a. Pure freshly precipitated sulphate of strontia was digested in the cold for two days with dilute sulphuric acid of spec. grav. 4·8. 150 grams of the filtrate left 0·3451 gram, so that 1 part dissolved 435 parts. In a second experiment the proportion was 1 : 429. The average is 1 : 432.

b. Another portion of sulphate of strontia was digested in the cold for two days with dilute muriatic acid of spec. grav. 8·5. 100 grams left 0·2115, and another 100 grams 0·2104 gram. The average solubility of sulphate of strontia in muriatic acid of the above strength is therefore expressed by the proportion 1 : 474.

c. A third portion was digested in the cold for two days with pure dilute acetic acid containing 15·6 per cent of hydrated acetic acid. 100 grams of the filtrate left 0·0126 and 0·0129 gram. This gives the average 1 : 7843.

4. *Ammoniacal Solution of Protoxyd of Nickel, a means of distinguishing Silk and Cotton;* by Professor SCHLOSSBERGER, (J. f. pr. Chem., lxxiii, p. 369, cited from Chem. Gazette, No. 383, p. 372).—The violet-blue solution of freshly precipitated hydrate of protoxyd of nickel exerts an extremely remarkable action upon silk. If silk threads be brought in contact with a drop of this solution under the microscope, peculiar vermicular movements are observed in it, and at the same time they swell up considerably and acquire a yellow color. Soon afterwards the outlines become pale, in part (with raw silk) accompanied by considerable inflations or ruptures of the external envelopes of the fibres, and finally complete solution takes place. If silk be thoroughly kneaded up in a test-glass by means of a glass rod with the blue solution of nickel, it soon becomes of a brownish yellow color, resembling that of hydrated oxyd of iron; it then becomes slippery and gelatinous, and at last furnishes a brownish yellow solution.

If the silk fibres be washed with water in the first stage of their alteration by the author's new reagent, all further action ceases; in later stages of change, they are also fixed by washing. The same thing is effected by a drop of weak acid, by the addition of which the fibre also loses somewhat in volume, and becomes colorless.

Solutions of alkaline salts do not precipitate the solution of silk, nor do solutions of sugar and gum. It is remarkable that a solution of $Cl\,NH^4$ restores the original violet-blue color to the brownish yellow solution of silk in $NiO\,NH^3$, without separating anything. The solution of silk and nickel is abundantly precipitated by acids, and this precipitate (in colorless flakes of the aspect of hydrate of alumina) is permanent, when the acids are not too strong. The fluid exhibits a greenish color.

Cellulose (cotton) is not at all altered, even by immersion for several days in the solution of $NiO\,NH^3$; after lying in it for three days, the fibres of cotton still presented their original form under the microscope, and there was no trace either of swelling or coloration. Potato-starch also did not swell up in it; inuline was gradually dissolved.

No analogous action has yet been produced upon silk by means of solutions of CoO, ZnO, and Al^2O^3 in NH^3. In the coloration, swelling, and solution of silk by NiO, it is essentially a matter of indifference whether the silk employed be raw silk, or silk deprived of its dressing by boiling.

5. *The Discovery of the Composition of Water*, (Athen., No. 1635, Feb. 26, 1859).—Mr. Bennett, of the British Museum, has addressed a letter to Sir Benjamin Brodie, Bart., which contains indisputable evidence in favor of Cavendish's claim to the discovery of the composition of water. The evidence was discovered by the late Robert Brown, Esq., and is not derived from any unpublished document, but forms part of a section of De Luc's 'Idées sur la Météorologie,' which, although specially entitled "*Anecdotes relatives à la découvertes de l'Eau sous la forme d'Air*, appears entirely to have escaped the notice of those who have advocated Cavendish's claims. It is the more conclusive as coming from De Luc, the "*ami zélé*," as he justly terms himself, of Watt, and who, in relation to this question, believed himself "à portée d'en connoître toutes les circonstances."

The testimony of De Luc is as follows:—"Vers la fin de l'année 1782, j'allai à *Birmingham*, où le Dr. Priestley s'étoit établi depuis quelques annèes. Il me communiqua alors que, M. Cavendish, d'après une rémarque de M. Warltine, qui avoit toujours trouvé de l'eau dans les vases où il avoit brûlé un mélange de *l'air inflammable* et *d'air atmosphérique*, s'étoit appliqué à découvrir la source de cette eau, et qu'il avoit trouvé qu'un mélange *d'air inflammable* et *d'air déphlogistique* en proportion convenable, étant allumé par l'étincelle électrique, se convertissoit tout entier en *eau*.—Je fus frappé au plus haut degré de cette découverte."—*Idées sur la Météorologie*, Tome 2, 1787, pp. 206–7.

The italics and inverted commas are De Luc's own.

In this communication, made by Cavendish to Priestley, the theory of the composition of water is clearly indicated. The two gases—known to have been hydrogen and oxygen—were mixed together *in due proportion*, and by means of the electric spark were *entirely converted* into water. Referring to one of Cavendish's experiments, as recorded in his Journal, Lord Jeffrey, the most candid and judicious of Watt's advocates, has said, "If he (Cavendish) had even stated in the detail of it that the airs were *converted*, or *changed*, or *turned* into water it would probably have been enough to have secured to him the credit of this discovery as well as to have given the scientific world the benefit of it in the event of his death before he could prevail on his modesty to claim it in public."—*Edinburgh Review*, vol. 87, p. 125.

The evidence which this distinguished critic and judge regarded as sufficent to establish Cavendish's claim is now afforded, not by a note in his private journal, but by the testimony of the zealous friend of Watt, who states that it was communicated to Priestley towards the end of 1782, that is to say, several months before Watt drew his own conclusions from Priestley's bungling repetition of Cavendish's experiments. It was, moreover, published to the world and suffered to remain uncontradicted while all the parties were alive and in frequent intercourse with the author and with each other.

It is a remarkable fact that notwithstanding all the researches made on many occasions during the past half-century on the claim to the discovery of the composition of water, and even within the past year by eminent *savants*, the evidence published by De Luc, in 1787, remained undiscovered, with an exception, that being, as above mentioned, the late Robert Brown, Esq., and this is the more remarkable when we remember

that De Luc's chapter, already referred to, is especially devoted to anecdotes on the subject in question.

[We happen to know that this knowledge had long been in Mr. Brown's possession, at least for the last nine or ten years of his life, during which the water-controversy has been so rife, if not from the time when he furnished Cavendish's biographer with incidental information; also that he regarded it as decisive of the controversy. So remarkable a retinence in such a case is probably unparalleled, but is perfectly characteristic. It is to be hoped that Mr. Brown has left some record or indication to show how he reconciled De Luc's statement, in 1787, of what occurred in 1782 with his (De Luc's) letters to Watt in 1783–4, now published in the Watt correspondence. The only apparent solution of this new enigma, consistent with the idea of De Luc's truthfulness, is that he had at the time misunderstood Priestley's verbal communication, but had been afterwards corrected by Priestley. That the name of "Cavendish" is not a *lapsus* for that of Watt is pretty certain. So, De Luc's statement, published in 1787,—at a time when Watt and Cavendish were in personal communication—may be regarded as his own reversal of the views he had expressed in his correspondence with Watt, and even as an indication of the understanding of the parties at the time. And it is singular that its republication now should close the long controversy which followed the resuscitation of this correspondence by Arago.—Eds.]

6. *On the Electric Conducting-Power of the Metals;* by Augustus Matthiessen, Ph.D., (L. E. and D. Phil. Mag., vol. xvi, p. 219).—The following values for the conducting power of the metals were determined in the Physical Laboratory at Heidelberg, under the direction of Professor Kirchhoff, by the same method as is described in the "Philosophical Magazine," Feb. 1857.

	Conducting Power	at Temp. in Centigrade degrees.
	°	°
Silver,	100	0
Copper, No. 3,	77·43	18·8
Copper, No. 2,	72·06	22·6
Gold,	55·19	21·8
Sodium,	37·43	21·7
Aluminium,	33·76	19·6
Copper, No. 1,	30·63	24·2
Zinc,	27·39	17·6
Magnesium,	25·47	17·0
Calcium,	22·14	16·8
Cadmium,	22·10	18·8
Potassium,	20·85	20·4
Lithium,	19·00	20·0
Iron,	14·44	20·4
Palladium,	12·64	17·2
Tin,	11·45	21·0
Platinum,	10·53	20·7
Lead,	7·77	17·3
Argentine,	7·67	18·7
Strontium,	6·71	20·0
Antimony,	4·29	18·7
Mercury,	1·63	22·8
Bismuth,	1·19	13·8

Alloy of Bismuth 32 parts, Antimony 1 part,	0·884	24·0
Alloy of Bismuth 12 parts, Tin 1 part,	0·519	22·0
Alloy of Antimony 2 parts, Zinc 1 part,	0·413	25·0
Graphite, No. 1,	0·0693	22·0
Graphite, No. 2,	0·0436	22·0
Gas-coke,	0·0386	25·0
Graphite, No. 3,	0·00395	22·0
Bunsen's Battery-coke,	0·00246	26·2
Tellurium,	0·000777	10·6
Red Phosphorus,	0·00000123	24·0

All the metals were the same as those used for my thermo-electric experiments, with the exception of cadmium, which was purified by my friend Mr. B. Jegel.

The alloys of bismuth-antimony, bismuth-tin, antimony and zinc were determined in order to ascertain, whether, as they give, with other metals, such strong thermo-electric currents, they might be more advantageously employed for thermo-electric batteries than those constructed of bismuth and antimony.

Coppers No. 1, 2, 3 were wires of commerce. No. 1 contained small quantities of lead, tin, zinc, and nickel. The low conducting power of No. 1 is owing, as Prof. Bunsen thinks, to a small quantity of suboxyd being dissolved up in it.

Graphite No. 1 is the so-called pure Ceylon; No. 3 purified German, and No. 2 a mixture of both. The specimens were purified by Brodie's patent and pressed by Mr. Cartmell, to whom I am indebted for the above.

The conducting power for gas-coke, graphite, and Bunsen's battery-coke increases by heat from 0° to 140° C.; it increases for each degree 0·00245, *i. e.* at 0° C. the conducting power =100, and between the common temperature and a light red heat about 12 per cent. The following metals were chemically pure:—Silver, gold, zinc, cadmium, tin, lead, antimony, quicksilver, bismuth, tellurium. Those pressed were sodium, zinc, magnesium, calcium, cadmium, potassium, tin, lead, strontium, antimony, bismuth, tellurium, and the alloys of bismuth-antimony and bismuth-tin. The way in which these wires were made is described in the "Philosophical Magazine" for February, 1857.

II. MINERALOGY AND GEOLOGY.

1. *Note on Rammelsberg's results with regard to the Composition of the Titanic Iron Ores;* by James D. Dana.—In this volume, at page 127, an abstract is given of the important researches of Prof. Rammelsberg on the titanic iron ores. One of the conclusions to which he arrives is, that they are compounds in different proportions of titanate of protoxyd of iron (FeO, TiO^2) with Fe^2O^3, in which part of the FeO is often replaced by magnesia (MgO). The proportions of the two members in different varieties are mentioned, but the numbers given are in general only approximate results from the analyses.

The great dominant fact in the titanic irons is their isomorphism with hematite, Fe^2O^3, and if we adopt Laurent's view of the constitution of such compounds, instead of looking for a titanate and sesquioxyd com-

bined, all the twelve varieties, with two or three exceptions, come very closely under the general formula M^2O^3,—M standing for all the metals (iron, titanium, manganese and magnesium) present. The following table shows that the coincidence for the varieties analyzed is quite remarkable —all but three or four giving almost exactly the ratio 1 : 1·5=2 : 3.

	M	O	Ratio.		M	O	Ratio.
Var. 1.	21·77	32·11	=1 : 1·48	Var. 7.	20·52	30·80	=1 : 1·50
" 2.	22·71	54·64	=1 : 1·52	" 8.	20·29	30·62	=1 : 1·51
" 3.	20·67	31·55	=1 : 1·50	" 9.	20·14	30·29	=1 : 1·50
" 4.	20·09	32·11	=1 : 1·60	" 10.	20·07	30·14	=1 : 1·50
" 5.	20·58	31·48	=1 : 1·53	" 11.	20·23	30·44	=1 : 1·50
" 6A.	21·17	31·67	=1 : 1·50	" 12.	20·18	30·22	=1 : 1·50
" 6B.	20·62	31·64	=1 : 1·54				

The formula M^2O^3 appears to express the true nature of the compound.

2. *Kaba-Delreczin Meteorite.*—On the 15th of April, 1857, at 10^h P. M., a meteorite fell near Kaba in the vicinity of Delreczin in Hungary, and is now in a public Cabinet at that place. It is named the Kaba-Delreczin meteorite. Its weight before being broken was 7 pounds; but is now reduced to 5½ pounds. It has not been analyzed.

3. *Ohaba Meteorite.*—On the 10th of October, 1857, some time after midnight there was a fall of a meteorite in the commune of Ohaba, east of Carlsburg. It is pyramidal in form, 14½ inches in height, and weighs 29 pounds. Specific gravity according to Dr. Grailich, 3·1103. It contains, according to Dr. Birkeisen:

Insoluble silicate (olivine),	44·83
Soluble silicate (augite and a feldspar),	18·27
Nickeliferous iron (Fe 21·40, Ni 1·80),	23·76
Sulphuret of iron,	13·14
	100·00

The specimen is in the Hof. Mineral Cabinet of Vienna.

4. *Geological Explorations in Kansas Territory;* by F. B. Meek and F. V. Hayden, (Proc. Acad. Nat. Sci. Philad., Jan. 1859).—This paper gives the results of the most extensive explorations of the Kansas rocks that have yet been made. They were undertaken last summer by Messrs. Meek and Hayden, and were carried forward with their well-known care and ability. The paper includes details respecting the Permian and Carboniferous rocks, their order of succession and characteristic fossils, and closes with descriptions of a considerable number of species. We cite a few pages giving a general section of the series, with their remarks upon the strata.

"As our examinations along the Kansas and Smoky Hill rivers above this point were made in more detail, where the outcrops were more frequent and continuous, we have, as we believe, been able to trace out the connections and order of succession of the various strata with considerable accuracy. Hence, we give below a general section of the rocks in this region, commencing with the Cretaceous sandstones on the summits of the Smoky Hills, lat. 38° 30′ N., long. 98° W., and descending through the various intermediate formations seen along the Smoky Hill and Kansas rivers, to the base of the bluff already mentioned, opposite the mouth of Big Blue river, on the Kansas. It is true, there are a few gaps in this section, where we were unable to see the beds along some of the slopes, but as we know the position in the series, as well as the extent of these gaps, it will be easy to determine, when a greater number of exposures have been examined, the nature of the beds occupying them.

General section of the Rocks of Kansas Valley from the Cretaceous down, so as to include portions of the upper Coal measures.

Feet.

1. Red, brown, and yellowish, rather coarse-grained sandstone, often obliquely laminated, and containing many ferruginous concretions; also, fossil wood and many leaves of dicotyledonous trees, some of which belong to existing genera, and others to genera peculiar to the Cretaceous epoch. *Locality, summit of Smoky Hills*.......... 60

2. Whitish, very fine grained argillaceous sandstone, underlaid by bluish purple and ash colored clays. *Locality same as preceding*.......... 15

3. Long, gentle slope, with occasional outcrops of ash-colored red, blue, and whitish, more or less laminated clays, with thin beds of sandstone. *Locality same as preceding, and extending down at places nearly or quite to the bluffs of Smoky Hill river;* thickness about.......... 200

4. Red sandstone, with some layers of hard, light gray calcareous, do., and both containing ferruginous concretions. *Locality, bluffs Smoky Hill river, five or six miles above Grand Saline river.* Probably local, thickness seen about .. 15

5. Bluish, red, light yellow, and gray clays, and soft claystones, with sometimes a few thin layers of magnesian limestone. In many places these clays have been traversed in every direction by cracks, into which calcareous and argillaceous matter have found their way, and subsequently become consolidated so as to form thin seams of impure yellowish limestone, which cross and intersect each other at every angle. The red clays are usually less distinctly laminated, contain more arenaceous matter, and often show ripple marks on the surfaces. *Locality, bluffs along Smoky Hill river, above the mouth of the Grand Saline*.......... 60

6. Light gray, ash-colored, and red clays, sometimes arenaceous, and often traversed by cracks, filled with calcareous matter as in the bed above,—alternating with thin layers and seams of gypsum. *Locality, near mouth of Smoky Hill river*.......... 40

7. Rather compact amorphous white gypsum, with near the base disseminated crystals, dark colored do. *Locality same as last*..........4½ to 5

8. Alternations of ash-colored, more or less arenaceous clays, with thin beds and seams of gypsum above; towards lower part, thin layers of claystone, and at some places soft magnesian limestone. *Locality same as last*.......... 50

9. Rough conglomerated mass, composed of fragments magnesian limestone and sandstone, with sometimes a few quartz pebbles, cemented by calcareous and arenaceous matter; variable in the thickness and probably local. *Locality, south side of Smoky Hill river, ten or twelve miles below Solomon's Fork*...seen 18

10. Bluish, light gray, and red laminated clays, with seams and beds of yellowish magnesian limestone, containing *Monotis Hawni, Myalina perattenuata, Pleurophorus? subcuneatus, Edmondia? Calhouni, Pecten* undet., and *Spirigera* near *S. subtilita;* also *Nautilus eccentricus, Bakevellia parva, Leda subscitula, Axinus rotundatus,* and undetermined species of *Bellerophon, Murchisonia, &c. Locality, near Smoky Hill river, on high country south of Fort Riley, as well as on Cottonwood creek*.......... 90

11. Light grayish and yellow magnesian limestone, in layers and beds sometimes alternating with bluish and other colored clays, and containing *Solemya,* a *Myalina* near *M. squamosa, Pleurophorus? subcuneatus, Bakevellia parva, Pecten* undt., and a *Euomphalus* near *E. rugosus;* also, a *Spirigera* allied to *S. subtilita,* but more gibbous, *Orthisina umbraculum? O. Shumardiana, &c. Locality, summit of the hills, near Fort Riley and above there; also seen on Cottonwood creek*..........25 to 35

12. Light grayish yellow, rather granular magnesian limestone, containing spines and plates of *Archæocidaris;* a few fragments of small *Crinoid* columns, *Spirifer* similar to *S. lineatus,* but perhaps distinct; also same *Spirigera* seen in beds above, *Orthisina Shumardiana, O. umbraculum?* and *Productus Calhounianus. Forms distinct horizon near summit of hills in vicinity of Fort Riley, also seen on Cottonwood creek*..........7 to 8

13. Soft argillo-calcareous beds, apparently local. *Kansas Falls*.......... 5

Feet.

14. Light grayish and yellowish magnesian limestone, containing many concretions of flint, also the same *Spirigera* found in beds above, and *Productus Norwoodi*, *P. Calhounianus*, with *Discina tenuilineata*, and an undetermined *Monotis*. *Fort Riley and below; also at Kansas Falls and on Cottonwood creek.* 38

15. Alternations, bluish, yellowish and brown clays, with a few thin seams of limestone. *Fort Riley, Kansas Falls; also below Fort Riley, and on Cottonwood creek*.. 35

16. Light yellowish magnesian limestone, containing *fucoidal* markings, fragments of small *Crinoid* columns, *Pecten*, *Allorisma*, *Spirigera*, *Orthisina umbraculum?* *O. Shumardiana*, *Discina tenuilineata*, &c. *Lower quarry at Fort Riley, and at other places above and below Fort R., as well as on Cottonwood creek.* ....4 to

17. Alternations of blue, red, and light gray clays, with sometimes thin layers and seams of magnesian limestone. *Fort Riley*.................... 28

18. Light gray and whitish magnesian limestone containing *Spirigera*, *Orthisina umbraculum?* *O. Shumardiana*, *Productus Calhounianus*, *Acanthocladia Americana*, and undt. *sp. Cyathocrinus*. Lower part containing many concretions of flint. *Fort Riley and on Cottonwood creek.* Whole thickness about.. 40

19. Brown, green, and very light gray clays, alternating; contains near the upper part fragments of *Crinoid* columns, *Synocladia biserialis*, *spirigera*, *Productus Norwoodi*, *Chonetes mucronata*, *Orthisina Shumardiana*, *Orthisina umbraculum*, &c., with teeth of *Petalodus Alleghaniensis*. *Fort Riley*.......... 14

20. Alternations of rather thin layers light yellowish magnesian limestone, and various colored clays; the limestone layers containing *Monotis*, *Synocladia biserialis*, &c. *Locality same as last*.. 32

21. Slope, no rocks seen. *Below Fort Riley*.......................... 25

22. Whitish, or very light gray magnesian limestone, rendered porous by cavities left by the weathering out of numerous *Fusulina*. This is the highest horizon at which any remains of *Fusulina* were met with. *Some four miles below Fort Riley, along a creek on the south side of the Kansas, and apparently not more than ten feet above it*.. 2

23. Bluish, light gray, and brown clays, with occasional layers of magnesian limestone. *Chonetes mucronata*, *Orthisina umbraculum?* *Monotis*, *Fusulina*, &c. *Ten miles below Fort Riley*.. 35

24. Hard, very light yellowish gray magnesian limestone, with *Fusulina*, and spines of *Archæocidaris*. Forms a marked horizon near the *same locality as last.* 6

25. Slope, with occasional exposures, thin layers of *Fusulina* limestone, and seams of gray limestone containing *Myalina*, *Monotis*, *Pecten*, and fragments of *Synocladia biserialis*. *Near same locality as last*................. 36

26. Light gray argillaceous limestone, showing on weathered surfaces a somewhat laminated structure; contains large spines of *Archæocidaris*. *Near Ogden Ferry, and Manhattan*.. 9

27. Gray limestone, often fragmentary, with much clay above; lower part hard, and more or less cellular in middle. *Locality same as last*.......... 5

28. Whitish clays and claystones, with a thin layer of hard compact gray limestone near the middle. *Locality same as last*........................ 10

29. Light greenish indurated clays. *Same locality*........................ 8

30. Hard, heavy bedded, white argillaceous limestone, containing *Monotis* and *Avicula*. *Ogden Ferry, and below there*.............................. 5

31. Very thinly laminated dark green shale. *Three miles nearly east of Ogden Ferry, on McDowell's creek; also at Manhattan, on the Kansas*.......... 1

32. Light greenish and flesh-colored hard argillaceous limestone, with *Spirifer cameratus*. This is the highest horizon at which we found this species. *Same localities*.. 8

33. Alternations of bluish, green and red more or less calcareous laminated clays, light gray limestones and claystones, with *Pecten*, *Monotis*, and fragments of *Crinoid* columns. *Same localities*................................ 30

34. Alternations bluish, purple, and ash colored calcareous clays, passing at places into claystones, and containing in a thin bed near the middle, *Spirifer planoconvexa*, *Spirigera subtilita*, *Productus splendens?* *Rhynchonella Uta*, &c. *Locality same as preceding*.. 12

	Feet.
35. Blue, light gray, and greenish clays, with occasional harder seams and layers of claystone and limestone. *Same locality*..........................	32
36. Somewhat laminated claystone of light gray color, with more or less calc spar near lower part. *Manhattan*..........................	19
37. Alternations of dark gray and blue, soft decomposing argillaceous limestone, with dark laminated clays, or soft shale, containing great quantities of *Fusulina cylindrica*, *F. cylindrica* var. *ventricosa*, *Discina Manhattanensis*, *Chaetetes*, and fragments *Crinoids*; also, *Chonetes Verneuiliana*, *C. mucronata*, *Productus splendens?* *Retzia Mormonii*, *Rhynchonella Uta*, *Spirigera subtilita*, *Spirifer cameratus*, *S. planoconvexus*, *Euomphalus* near *E. rugosus*, and *Synocladia biserialis*; also *Cladodus occidentalis*. *Locality, same as last*............	18
38. Soft bluish shale, with yellow laminated arenaceous seams below, containing fucoidal markings. *Same locality*..........................	25
39. Two layers gray argillo-calcareous rock, separated by two feet of dark green and ash-colored clays. The calcareous beds contain fragments of *Crinoids*, *Chonetes*, and *Myalina* in undt. species. *Same locality as last*.........	4½
40. Light greenish, yellow, and gray clays and claystones, extending down nearly to high water mark of the Kansas, *opposite the mouth of Blue River*...	27

The foregoing general section of the strata seen along the valley of Kansas and Smoky Hill rivers, from the mouth of Blue river to the 98th degree of west longitude, is presented in its present form more with a view of illustrating the vertical range of the organic remains found in these rocks, than as an attempt to group the beds into formations that may be expected to preserve their distinctive lithological characters throughout areas of any great extent. As this has necessarily been done from a knowledge of only a portion of the fossils characterizing these strata, it is quite probable, when more extensive collections are obtained, that it may be found necessary even on this principle, to classify and group the beds somewhat differently. We are also aware that some of these beds probably increase or diminish greatly in thickness, or may even entirely thin out, at no very great distances from the localities where we saw them. * * *

It will be observed we have in this general section, without attempting to draw lines between the systems or great primary divisions, presented in regular succession the various beds with the fossils found in each, from the Cretaceous sandstone on the summits of the Smoky Hills, down through several hundred feet of intermediate doubtful strata, so as to include the beds containing Permian types of fossils, and a considerable thickness of rocks in which we find great numbers of upper coal-measure forms. We have preferred te give the section in this form because, in the first place, the upper coal measures of this region pass by so imperceptible gradations into the Permian above, that it is very difficult to determine, with our present information, at what particular horizon we should draw the line between them, while on the other hand, it is equally difficult to define the limits between the Permian and beds above, in which we found no fossils.

Beginning near the base of this section, we find we have in great numbers the following well known and widely distributed coal-measure fossils, viz., *Fusulina cylindrica*,* *Chonetes Verneuiliana*, *Productus splen-*

* In Russia, *Fusulina cylindrica* is said to occur only in the upper part of the lower Carboniferous series; but the fossil generally referred to that species in this country, appears to be confined to the coal measures. We have some doubts in regard to the identity with the Russian species.

dens, (or a closely allied species,) *Retzia Mormonii*, *Rhynchonella Uta*, *Spirigera subtilita*, *Spirifer cameratus*, *S. planoconvexus*, and a *Euomphalus*, similar to *E. rugosus* of the coal measures, while the few new and undetermined species associated with these, are, for the most part, also decidedly more nearly allied to Carboniferous than Permian forms. We should here remark, however, that we occasionally met with a species of *Monotis*, allied to the Permian species *M. speluncaria* and *Synocladia biserialis*, (also regarded in the old world as a Permian genus,) at horizons far beneath the base of this section, between Manhattan and the Missouri. We even found a single specimen of this *Monotis* as low down as bed No. 9, of the section taken near the landing at Leavenworth City, which must occupy a position several hundred feet below the lowest beds of the above section. Still as this shell is very rare in the lower rocks, and the *Synocladia* is a distinct species from the well known Permian form of the old world, while they are both, at these horizons, associated with great numbers of the common well-known coal-measure species, we can only regard their presence in these beds as establishing the existence of these genera at an earlier period in this country, than in the old world. This, it seems to us, is more philosophical than it would be to place all this great thickness of strata, with their vast numbers of well known coal-measure species, in the Permian, merely because we also find with these occasionally a few forms which would in the old world be regarded as characteristic of the Permian epoch.

Taking it for granted then, that we have carried this section down far enough to include, not only all the beds containing almost exclusively Permian forms, but a considerable portion of the upper coal measures, it will be interesting to notice, as we ascend in the series, how far each of the coal-measure species mentioned in the lower part of the section, as well as of a few others that occur above and below, range upwards. Thus we see that *Fusulina cylindrica* var. *ventricosa*, *Chonetes Verneuiliana*, and *Retzia Mormonii* were not met with above division No. 37; while *Spirifer planoconvexus*, *Productus splendens?* and *Rhynchonella Uta*, were not observed above 34, nor *Spirifer cameratus* above 32. *Fusulina cylindrica*, of the slender variety so common in the coal measures of Kansas and Missouri, was not seen above 22; nor was any species or variety of that genus observed above this horizon.

Apparently the same species of *Monotis*, mentioned at various horizons far beneath, were occasionally met with in 30, 25, 23, and 20, generally associated with the same species of *Synocladia*, ranging far down into the upper coal measures. In division No. 19, we again met with the *Synocladia biserialis*, and a *Spirigera* allied to *S. subtilita*, if not identical, along with a new species of *Chonetes* we have called *C. mucronata*, which ranges down into the beds near the base of the section. Along with these were also *Productus Norwoodi* and *Orthisina Shumardiana*, both of which are common in the coal measures far below, and a large *Orthisina* similar to *O. umbraculum*, but apparently more finely striate.

Ascending through the intermediate beds to No. 12, we continue to meet with nearly all the species mentioned in 19, with the exception of *Chonetes mucronata*. We also have, first in 18, a large species of *Pro-*

ductus called *P. Calhounianus* by Professor Swallow; very similar to some varieties of *P. semireticulatus*, but thought by Prof. S., to present well marked internal differences. There is likewise added in 16, a large *Allorisma* and a *Spiriger* similar to *S. subtilita*, but much more gibbous; and in 14, *Discinia tenuilineatus* together with apparently the same *Monotis*, so often mentioned below. In 12, we also have added a small *Spirifer* similar to *S. lineatus*, but perhaps more nearly allied to the Permian species *Martinia Clannyana*, King.

The succeeding bed above, No. 11, appears also to contain a mingling of Permian with coal-measure forms, for we have in it the following Permian types, viz., *Myalina* very similar to *M. squamosa*, *Pleurophorus? subcuneatus*, *Bakevellia parva* and *Monotis Hawni*, along with a *Euomphalus* near *E. rugosus*, the same gibbous *Spirigera*, similar to *S. subtilita*, *Orthisina umbraculum?* and *O. Shumardiana*.

On passing into the next division above, No. 10, we find we have lost sight of all the characteristic Carboniferous forms, unless the *Spirigera* mentioned in some of the beds below be regarded as only a variety of *S. subtilita*, from which however, we think it specifically distinct; for with this exception, nearly all the fossils seen by us in this division, are such as would be regarded as Permian types. Although the number of *species* found by us in No. 10 is not great, *individual* specimens are often numerous. Above this horizon we saw no more fossils through a great thickness of various colored clays, claystones, &c., until ascending to the Cretaceous sandstones crowning Smoky Hills.

If we do not admit the existence in this region of an intermediate group of rocks, connecting by slight gradations the Permian above, with the coal measures below, and must draw a line somewhere, below which all is to be regarded as Carboniferous, and all above as Permian, we should certainly, upon palæontological principles alone, carry this line up as far as the top of division No. 11. The passage from the Carboniferous to the strata containing Permian types, however, is so gradual here, that it seems to us no one, undertaking to classify these rocks without any knowledge of the classification adopted in the old world, would have separated them into distinct *systems*, either upon lithological or palæontological grounds, especially as they are not, so far as our knowledge extends, separated by any discordance of stratification, or other physical break.* Indeed the fact that some of the Permian types occurring in No. 10, were first introduced in beds below this, containing many Carboniferous species, would seem to indicate that even No. 10 may possibly have been deposited just before the close of a period of transition from the conditions of the Carboniferous, to those of the Permian epoch.

"The apparent absence of fossils in the beds above No. 10, renders it impossible, with our present information, to determine with certainty the upper limits of the series containing Permian forms. It is true, there is

* We have been informed by Dr. J. G. Norwood, former State Geologist of Illinois, that the rocks in that State, referred by him and others to the same epoch as the Kansas Permian beds, rest unconformably upon the Coal measures. This, however, would be impossible in Kansas, since no disturbance of the strata occurred there, until after the close of the Cretaceous era, which would of course, not only cause the Cretaceous and Carboniferous, but all the intermediate beds, to dip at the same angle.

at places a kind of conglomerated mass, occupying the horizon No. 9, which might appear to form a natural line of division between the beds containing the Permian fossils, and those above, in which we found no organic remains; but this seems to be local, and although there is a new feature presented by the zone of gypsum deposits above it, we find between the beds and layers of gypsum, and far above the horizon at which they occur, bluish, greenish, and other colored clays, not only similar to those between the beds and layers of limestone containing the Permian fossils in division No. 10, but also precisely like the laminated clays between the beds of limestone of the upper Carboniferous series far below. Again, in these clays of the gypsum zone, as well as through a considerable thickness of clays above it, there are occasional seams of claystone, which sometimes pass into seams of magnesian limestone, exactly like some of those containing Permian fossils, in division No. 10. We saw no fossils in these seams amongst the gypsum-bearing beds, nor higher in the series, but it is probable they may yet be found in some of the more calcareous portions.

Another fact apparently indicating some kind of relation between the gypsum-bearing beds, as well as some of the higher deposits, and the rocks below, is, that we often find both in the clays between the beds of gypsum, and those between the limestone containing the Permian fossils, the same peculiar appearance caused by the cracking of the clays and subsequent infiltration of calcareous matter, seen in division No. 5. At some places the thin plates of limestone formed by the impure calcareous matter filling these cracks, may be seen ramifying through some rather thin beds of these clays in all directions, so as to cross and intersect each other at every angle. Where beds of this kind have been exposed for any length of time along near the tops of bluffs, the softer clays filling the interstices, often weather out, so as to leave a curious cellular mass, with the numerous angular cavities.

From these facts we are inclined to suspect,—though we are fully aware that it is a question which can only be determined upon evidence derived from organic remains,—that not only the gypsum-bearing deposits, but a large portion, if not all, of division No. 5, belongs to the same epoch as the beds containing the Permian fossils below.

Between No. 5 and the Cretaceous above, there is still a rather extensive series of beds in which we found no organic remains; these may be Jurassic or Triassic, or both, though as we have elsewhere suggested, we rather incline to the opinion that they may prove to belong to the former. As we have fully discussed the question in regard to the Cretaceous age of the highest division of the foregoing section in a paper read before the Academy in December last, and in an article in the American Journal of Science, January, 1859, it is unnecessary for us to add anything further on that subject here.

As already stated, our observations along the Kansas valley, to within twelve or fourteen miles of the mouth of Big Blue river, were too isolated to determine in all cases the relations between outcrops seen at different places. Consequently, although we saw at several points along this part of the valley, indications of a westward or northwestward inclination of the strata, we were left in some doubt whether or not there is

a general inclination of the rocks in that direction, between Wabounse and the Missouri. Above this point, however, our observations being more connected, and the exposures more continuous, we were able to determine very satisfactorily that there is at least from near Wabounse, a uniform dip towards the west or northwest, so that in ascending the Kansas valley from this region, we are constantly meeting with more and more modern rocks, as those we leave behind pass beneath the level of Kansas. * * * *

From the foregoing statements it will be seen that in consequence of the dip of the strata to the northwest, and in some slight degree to the fall of the Kansas and Smoky Hill rivers, the whole of the foregoing general section below No. 12 passes beneath the level of the Smoky Hill, between the mouth of Blue river and Chapman's Creek. Consequently, the limestones of the succeeding beds above being thinner and less durable than those below, and separated by heavy beds of clay; we find, as might be expected, that the country here in the region of the mouth of Chapman's Creek, is much lower than at Fort Riley and below.

On reaching the mouth of Solomon's Fork, we found the face of the country characterized by long gentle grassy slopes, no part of it near the river apparently being elevated more than about 60 or 70 feet above its surface. A short distance beyond this, we caught the first glimpse of the Smoky Hills, which were seen in a direction a little south of west from us, rising above the surrounding low country like dark blue clouds above the horizon. On approaching these, we found them always situated several miles back from the river, and rising some three hundred and fifty feet above it. The immediate bluffs of the river here, are generally composed of divisions No. 4 and 5 of the foregoing general section, and that portion of these hills above the level of the summits of the bluffs along the river, is made up of division Nos. 3, 2, 1, of the same section. On the south side of the river these hills have but a comparatively thin capping of the sandstone No. 1, but on the north side we saw it showing a thickening on some of them of sixty feet.

From some of these hills on the north side of Smoky Hill river, between it and the Grand Saline, we had an extensive and beautiful view of the surrounding country. In the north and northwest, many similar hills were in sight, and as the dip of the strata here is in that direction, it is probable that some of this are not only chiefly made up of the sandstone No. 1, but surmounted by the other Cretaceous beds Nos. 2 and 3 of the Nebraska Cretaceous series; indeed, Dr. Engelmann found all these formations occupying this relation on Republican river, not more than seventy miles north of this.*

Although this paper is merely designed to give a brief sketch of the leading geological features of these portions of northeastern Kansas visited by us, we cannot close it without alluding to the truly great agricultural and other natural resources of this new and interesting territory. We mean no disparagement to other portions of the Mississippi valley, when we state, that after having travelled extensively in the Great West, and after having seen many of its most favored spots, we have met with no country combining more attractive features than Kansas Territory. Her

* See Report of Secretary of War, Dec. 5th, 1857, page 497.

geographical position gives her a comparatively mild and genial climate, intermediate between the extremes of heat and cold, while the rich virgin soil of her beautiful prairies is admirably adapted to the growth of all the great staple grain and root crops of the west.

It is true that in some districts there is rather a deficiency of timber, but as a general thing there is along the streams sufficient for the immediate wants of the country. In addition to this, the wonderful rapidity with which forests are known to have sprung up on similar prairie lands in Missouri, as the country became settled so as to keep out the annual fires, shows that the present scarcity of timber should not be regarded as presenting any serious obstable to the settlement of the most extensive prairie district in Kansas.

Before going out into the interior of the Territory, we had expected to find the whole country immediately west of Fort Riley comparatively sterile; on the contrary, however, we were agreeably disappointed at meeting with scarcely any indications of decreasing fertility as far as our travels extended, which was about sixty miles west of Fort Riley. Here we found the prairies clothed with a luxuriant growth of grass, and literally alive with vast herds of buffalo that were seen quietly grazing as far as the eye could reach in every direction. Even on the high divide between the Smoky Hill and Arkansas rivers, south of this, we found the soil rich and supporting a dense growth of grass; and from all we could learn from persons who have gone further out, the same kind of country extends for a long distance beyond this, towards the west. Hence we infer that the belt of unproductive lands between the rich country on the east, and the eastern base of the Rocky Mountains on the west, is much narrower than is generally supposed; and even this so-called desert country is known to possess a good soil, which may be rendered fruitful by artificial irrigation.

In regard to the mineral resources of Kansas, we have at present only time and space to say a few words. As already stated, coal is known to exist, though its extent is not yet fully determined, at several localities in the region of Leavenworth City, while the geological structure of the country, as well as discoveries already made, warrant the conclusion that this important and useful mineral abounds at many localities south of there. Limestone suitable for building purposes, and the production of quicklime, exist throughout large areas, while inexhaustible beds of gypsum are known to occur at several places not far west of the mouth of Solomon's river. Near this place we likewise saw in the lower Cretaceous rocks crowning the summits of the Smoky Hills, deposits of iron ore, but were unable to determine in the limited time at our command, whether or not it exists in large quantities."

5. *On the Tertiary Flora of the vicinity of Vienna;* by Dr. C. von Ettingshausen, (Abhandl. der k. k. Geol. Reichs. Wien, vol. ii).—This paper contains descriptions of 33 species which are illustrated by figures on five 4to plates. The principal conclusions from the facts are these:

The Flora belongs to the Miocene period. It is closely analogous to that of the Miocene deposits of Upper Styria at Parschlug and Fohnsdorf, Leoben, etc. It is also near that of Swoszowice in Galicia, and has some relations to that of Bilin in Bohemia, and of Œningen, and St. Gallen in Switzerland.

Among the species 1 of them has a representative in Central Europe, 4 in Southern Europe, 2 in Central Asia, 10 in North America, 2 in South America, 6 in the East Indies, and 2 in Australia.

The Climate indicated is subtropical or from 15° *to* 21° *R.*

The especially tropical species are *Artocarpidium cecropiæfolium*, *Daphnogene polymorpha*, *Cissus platanifolia*, *Sterculia Vindobonensis*, *Pterospermum dubium*, *Cupanodes miocenicus.* = 6.

The subtropical are *Laurus Swoszowiciana*, *Hakea pseudo-nitida*, *Dryandra Vindobonensis* (the last two Australian in type), *Bumelia ambigua*, *Diospyros pannonica*, *Andromedites paradoxus*, *Rhamnus Augustinii*, *Myrtus Austriaca*, *Leguminosites macharioides*, *L. ingæfolius*, *Cassia ambigua.* = 11.

The warm temperate species are *Cyperites tertiarius*, *Potamogeton Ungeri*, *Pinites Partschii*, *Betula prisca*, *B. Brongniartii*, *Alnus Kefersteinii*, *Fagus castaneæfolia*, *Quercus Haidingeri*, *Planera Ungeri*, *Liquidambar europæum*, *Styrax pristinum*, *Acer pseudocreticum*, *Pterocarya Haidingeri.* = 13.

The species particularly North American in type are *Fagus castaneæfolia*, *Quercus Haidingeri*, *Liquidambar europæum*, *Laurus Swoszowiciana*, *Bumelia ambigua*, *Diospyros pannonica*, *Andromedites paradoxus.*

These beds contain *Hippotherium gracile* Kaup, among remains of Mammals; *Cybium Partschii* Münst., among Fishes; *Melanopis Martiniana* Fér., *M. Bouei* Fér., *M. pygmæa* Partsch, *Cardium apertum* Munst., *C. plicatum* Eichw., *Congeria subglobosa* Partsch., *C. spathulata* Partsch, among Mollusca; *Cytherina tenuis* Reuss among Crustacea.

6. *On the Tertiary Flora of Haring in the Tyrol;* by Dr. C. von Ettingshausen.—This paper is finely illustrated like the preceding. It describes 180 species.

The Flora is of the Eocene Period; of the same age with that of Sotzka in Upper Styria, Sagor in Krain, Monte Cromina in Dalmatia. 73 of the species have been described from other localities, and of these 41 are exclusively Eocene, 9 Miocene, and 23 common to Eocene and Miocene. Among the Miocene localities, that of Parschlug contains the largest number of the Haring species, namely 21; Oeningen contains 8, Bonn 7, Bilin 7, Vienna 3 and Heiligenkreuz near Kremnitz 2 identical species.

The Climate indicated by the plants is tropical or a mean temperature between 18 *and* 22° *R.*

There are several species of palms, and representatives of the families Moreæ, Artocarpeæ, Nyctagineæ, Monimiaceæ Laurineæ, Proteaceæ, Apocynaceæ, Bignoniaceæ, Sapotaceæ, Ericaceæ, Malpighiaceæ, Sapindaceæ, Euphorbiaceæ, Rhizophoreæ, Myrtaceæ, Papilionaceæ, Mimoseæ, etc.

The Flora has its closest analogies with that of Australia.—The Proteaceæ, Myrtaceæ, and Leguminoceæ constitute a third part of the flora. 55 species out of the whole are analogous to Australian types, 28 to East Indian, 23 to tropical America, 14 to South African, 8 to Pacific Island, 7 to North American and Mexican, 6 West Indian, 5 South European. The resemblance to Australia consists not merely in the number of the species, but also in the characters of the species—as the small oblong leathery leaves of the Proteaceæ and Myrtaceæ, the delicate branchlets of the Casuarinæ, the Cypress-like Australian species of *Frenela*

and *Callitris*, some peculiar species of Santalaceæ, Sapotaceæ, and Leguminoseæ. This relation to Australian vegetation is also evident in the fossil flora of Sotzka. Only 11 species have their representatives in the warm temperate climates, namely, *Juniperites ecenica*, *Pinites Palæostrobus*, *Quercus deformis*, *Q. Goepperti*, *Alnites Reussii*, *Planera Ungeri*, *Salicites stenophyllos*, *Laurus Lalages*, *Ilex Oreadum*, *Rhamnus colubrinoides*, *Juglans hydrophila*.

7. *Fossil Flora of Köflach, near Gratz, in Styria.*—Dr. C. R. von Ettingshausen has described the plants of Köflach in the Jahrbuch der k. k. geol. Reichsanstalt of Vienna, 1857, p. 738. They are of the Miocene era. There are 34 species, 12 of which are new, and 15 common with the flora of Fohnsdorf in Styria. More of the species occur in the Miocene of Switzerland than in the fossil flora of Schauerleithen near Pitten in Lower Austria, and but very few of them are found in the Parschlug deposit. The most common species are the *Sequoia Langsdorfi* Heer, and *Alnus Kefersteinii* Goepp.; and next to these *Glyptostrobus Europæus* Heer, *Betula Brongniartii* Ettings., and *Carpinus Heerii*. Among the peculiar species there is a *Myrica Joannis* Ettings., near the *Myrica Caroliniana* of North America, *Verbenophyllum aculeatum* Ettings., *Dombeyopsis helicteroides* Ettings., a tropical American type, *Euonymus Haidingeri* Ett., *Zizyphus Daphnogenes*, *Ceanothus macrophyllus* Ett., also related to a North American type, *Euphorbiophyllum crassinerve* and *E. Stiriacum* Ett., analogues of tropical Euphorbiaceæ. The paper is illustrated by many excellent wood-cuts and three plates.

8. *On some deposits in Tuscany containing Fossil Leaves;* by C. T. Gaudin of Lausanne, and Marquis C. Strozzi of Florence.—According to a notice in the Jahresb. k. k. Geol. Reichs. 1858, p. 135, these Tuscan deposits are situated in the upper part of the valley of the Arno, at Montajone, Bozzone and Malmerenda. These and the Piedmont beds of Chieri, Guarena, Sarzanello and others, and those of Sinigaglia, are on nearly the same horizon with those of Parschlug, Tallya, Swoszowice, Gleichenberg, Schossnitz, and also the Swiss localities at Oeningen, Ischel, Schrotzburg, Albis, Locle and the upper freshwater mollasse, while of older tertiary (Eocene above the nummulitic beds), are the deposits of Cadibona, Bagnasco, Stella in Italy; Lausanne, Aarwangen, Moulin-Monod, Hohe-Rhonen, Eriz, Rochette, Rivaz, Ralligen, Wäggis, in Switzerland; and Häring, Sotzka, Monte Promina of Austria.

9. *Post-tertiary of the St. Lawrence Valley;* by J. W. Dawson, (Canadian Nat. and Geol., iv, 23).—This paper describes and figures a number of new species of Foraminifers and Bryozoans from the Canada Post-tertiary, besides giving details respecting two or three localities, mentioned in the former paper, (see this Journal, [2], xxv, 275, and Can. Nat. and Geol. ii, 401). The following paragraphs are cited from the memoir.

Section at *Logan's Farm:*

Soil and Sand, - - - - - - - - -	1	9
Tough reddish clay, - - - - - - - - -	0	0½
Gray sand, a few specimens of *Saxicava rugosa*, *Mytilus edulis*, *Tellina Grœnlandica*, and *Mya arenaria*, the valves generally united, - - - - - - - - -	0	8

Tough reddish clay, a few shells of *Astarte Laurentiana*, and *Leda Portlandica*, - - - - - - - - -	1	1
Gray sand, containing detached valves of *Saxicava rugosa*, *Mya truncata*, and *Tellina Grœnlandica ;* also *Trichotropis borealis*, and *Balanus crenatus :* the shells in three thin layers, - - - - - - - - - - - - -	0	8
Sand and clay, with a few shells, principally *Saxicava* in detached valves, - - - - - - - - - -	1	3
Band of sandy clay, full of *Natica clausa*, *Trichotropis borealis*, *Fusus tornatus*, *Buccinnum undatum*, *Astarte Laurentiana*, *Balanus crenatus*, &c. &c., sponges and *Foraminifera*. Nearly all the rare and deep-sea shells of this locality occur in this band, - - - - - - - - - - -	0	3
Sand and clay, a few shells of *Astarte* and *Saxicava*, and remains of sea-weeds with *Lepralia* attached; also *Foraminifera*, - - - - - - - - - - - -	2	0
Stony clay, boulder clay.		

It thus appears that at Logan's farm we have littoral species at top, and that all the rare and deep-water fossils, as well as the *Lepraliæ* and *Foraminifera* occur in a comparatively thin band near the base of the deposit. This corresponds precisely with the order observed elsewhere in the vicinity of Montreal; though at Logan's farm the arrangement is somewhat more complex than in other localities.

Beauport.—I visited this celebrated deposit for the first time last autumn. At first sight it consists of a mass of stratified sand and gravel, equivalent to the Saxicava sand of Montreal, and resting on boulder clay. The overlying mass is filled with *Saxicava*, *Tellinæ*, &c.; and the underlying boulder clay as usual contains no fossils. My experience in the Montreal deposits, however, led me to expect a bed, however thin, representing the Leda clay, between these; and on searching at the junction of the two great beds above mentioned, I was gratified by finding a layer of sand about three inches in thickness, filled with the rarer shells of the deposit, characteristic of its deeper waters, such as *Fusus tornatus*, *Pecten Islandicus*, *Buccinum ciliatum*, *Modiolaria discors*, &c.* The *Rhynconella psittacea* occurs only in this layer, and in such a manner as to leave no doubt that it is buried here in situ, in the very spot where it lay anchored to the stones of the surface of the drift. On these stones, however, I found a new and interesting field for observation. In the thin layer above referred to, all the stones, as well as those that lay on the surface of the boulder clay or partly imbedded in it, were covered with the remains of marine creatures, especially *Balanus crenatus*, *Spirorbis sinistrorsa*, *Spirorbis spirillum*, *Lepralia* and *Hippothoa*. This layer, in short, evidently represented a time when the surface of the boulder clay, covered only by a thin layer of sand and stones, constituted the bottom of clear and deep water, before it became covered by the Saxicava sand. This bottom, although no clay has been deposited on it, represents the Leda clay at Montreal, and is exceedingly rich in the fossils usually found

* Sir C. Lyell notices the fact that these shells are more abundant in the lower part of the mass than above.

at the surface of that bed. *Foraminifera* occur in it, but they are comparatively rare, and, so far as I could find, only of species common at Montreal.

The paper concludes as follows:

"In so far as general conclusions in geology are concerned, the observations of the past year do not in any way conflict with the conclusions stated in my former paper.

The arrangement of the deposits at Logan's farm and Beauport, confirms the subdivision which I have attempted to establish, of an underlying non-fossiliferous boulder clay, a deep-water bed of clay or sand (the Leda clay of Montreal), and overlying shallow-water sands and gravels, the Saxicava sand of my former paper. This arrangement shows a gradual upheaval of the land from its state of depression in the boulder-clay period, corresponding with what has been deduced from similar appearances in the Old World. 'The upheaval of the bed of the glacial sea,' says Forbes, 'was not sudden but gradual. The phenomena so well described by Prof. Forchhammer in his essays on the Danish drift, indicating a conversion of a muddy sea of some depth into one choked up with sand banks, are, though not universal, equally evident in the British Isles, especially in Ireland and the Isle of Man.'*

We now have in all, exclusive of doubtful forms, sixty-three species of Marine Invertebrates from the Post-Pliocene or Pleistocene clays of the St. Lawrence valley. All, except four or five species belonging to the older or deep-water part of the deposit, are known as living shells of the Arctic or Boreal regions of the Atlantic. About half of the species are fossil in the Pleistocene of Great Britain. A majority of the whole are now living in the Gulf of St. Lawrence and on the neighboring coasts; and I have reason to believe that the dredging operations carried on by the officers of the Geological Survey in the past summer, will enable us to recognize all but a few as living Canadian species. In so far, then, as marine life is concerned, the modern period in this country is connected with that of the boulder clay by an unbroken chain of animal existence. These deposits in Lower Canada afford no indications of the terrestrial fauna; but the remains of *Elephas Primigenius* in beds of similar age in Upper Canada,† show that during the period in question great changes occurred among the animals of the land; and we may hope to find similar evidences in Lower Canada, especially in localities where, as on the Ottawa, the debris of land-plants and land-shells occur in the marine deposits."

10. *Second Biennial Report on the Geology of Alabama;* by M. Tuomey, A.M., Geologist to the State, and Prof. Geol. and Nat. Hist. Univ. of Alabama; edited from the Author's MSS. and other papers by J. W. Mallet, Ph.D., Prof. Chem. Univ. of Alabama.—The death of Prof. Tuomey left the Geological Survey of Alabama, that had been in progress under his charge, unfinished, and the preparation of his Second Report incomplete. A large part of the MS. was given to the printers in 1856; but only one or two signatures had been printed before his decease in March, 1857. The manuscript, partly in confusion and partly lost through some carelessness on the part of the printer, was afterwards put into the hands of

* Memoirs of Geological Survey. † Reports of Geol. Survey; Lyell's Travels.

Prof. Mallet, the Chemist of the Survey, and under his direction the results have been brought out. The volume treats briefly of the geology of the northern part of the State, giving some facts relating to the Silurian, Devonian and Carboniferous rocks, and also the metamorphic, with particular descriptions of iron ores and other economical products. It also mentions local details on the newer deposits of the State. The important statement is here made that the "*Gnathodon* beds" of Mobile bay, regarded as fossil beds by Lyell, are beyond doubt accumulations made by the aborigines of the country. They are often in heaps and contain ashes, burnt shells and charcoal, and bear no evidence of accumulation by wave action. The Report of Prof. Mallet, as Chemist of the Survey, contains analyses of a large number of rocks and ores.

11. *The Earthquake Catalogue of the British Association*, with the Discussions, Curves and Maps, etc.; by ROBERT MALLET, C.E., F.R.S., and JOHN WILLIAM MALLET, Ph.D., Prof. Chem. University of Alabama. From the Transactions of the British Association for the Advancement of Science, 1852 to 1858: being Third and Fourth Reports. Lond. 1858. —This thick 8vo volume contains the papers of the authors on earthquakes contributed to the British Association at the meetings from 1852 to 1858; of their thoroughness and great value it is not necessary here to speak. The work is indispensable to all who would understand the subject in its details and full breadth. The paper of 1858 is now for the first time issued, as the Report of the Association for last year has not yet been distributed: and it has special interest as it reviews the "Facts and Theories of Earthquake phenomena," and is illustrated by several fine maps.

12. *Catalogue of Mineralogical, Geological and Palæontological Specimens, Collections, Models, etc., offered for sale at the Rheinische Mineralien-Comptoir of Dr. A. Krantz, at Bonn in Prussia.* American edition, 1859, pp. 48.—Collectors of mineral and geological specimens will be glad to know that Dr. Krantz has published an American edition of his Catalogue, and that it may be obtained gratis on application to Messrs. J. F. Luhme & Co., who have been appointed his sole agents for the United States. This Catalogue will serve an excellent purpose in guiding mineralogists and others as to the comparative value of mineral and geological specimens, and at the same time it gives an idea of the extended scale upon which Dr. Krantz conducts business in his justly celebrated establishment.

III. BOTANY AND ZOOLOGY.

1. *American Weeds and Useful Plants: being a second and illustrated edition of Agricultural Botany, &c.;* by WM. DARLINGTON, M.D. Revised, with additions, by GEORGE THURBER, Prof. of Mat. Med. and Bot. in N. Y. College of Pharmacy. New York: Moore & Co. 1859, pp. 460, 18mo.—Dr. Darlington's Agricultural Botany was always a favorite, and in its new dress it deserves to be still more so. While regretting that the author, at his advanced age, "felt indisposed to assume the labor of a revision," we are satisfied that, if the task must fall into younger hands, it could hardly fall into better ones than those of the present editor.

He has extended the limits of the work so as to include the commoner medicinal plants, and such of our native shrubs as are worthy of cultivation, and has added a brief, remarkably well written, and pertinent introductory chapter upon the Structure of Plants, followed by a key to the natural orders of the plants described in the volume. In a book so full of information about useful plants, it seems hardly fair to promote the term 'weeds' to the head of the title—by these meaning "those intrusive and unwelcome individuals that will persist in growing where they are not wanted." But, after all, so far as botany can help him, the farmer needs rather to be instructed how to dispose of his enemies than how to make the most of his friends. This edition is illustrated by good wood engravings of many of the plants described, in great part from original drawings from the skillful pencil of Mr. Anthony Hochstein. A. G.

2. *Journal of the Proceedings of the Linnæan Society* (Botany), No. 10, (1858); contains:—

Synopsis of Legnotideæ, by George Bentham. He still regards these plants as forming a mere "tribe of *Rhizophoraceæ*," and as having "a general affinity with *Cunoniaceæ* and with *Lythraceæ*," as Brown long ago suggested. Mr. Bentham distinguishes nine genera, one of which is new, and about twenty-one species. One of the most interesting of these is a new *Crossostylis*, detected (in fruit only) by Prof. Harvey in the Feejee Islands, having fewer carpels in its gynæcium than Forster's *C. biflora*, for the elucidation of which we are indebted to the South Pacific Exploring Expedition under Capt. Wilkes. Mr. Bentham also contributes a

Notice of the Rediscovery of the genus Asteranthos, Desf., by Mr. Spruce.—Although ticketed as from Brazil, this curious plant was suspected to be African, because *Napoleona*, its only relative is African; but Spruce has now confirmed its American origin by finding it, in great abundance, upon the banks of one of the tributaries of the Casiquiare. Mr. Bentham inclines to Lindley's view of the close affinity of these two plants with the *Myrtaceæ*.

Monograph of the Eucalypti of Tropical Australia, with an arrangement, for the use of Colonists, according to the Structure of the Bark; by Dr. Ferdinand Müller, Government Botanist, Victoria.—The zealous and indefatigable Dr. Müller here describes 38 species in great part from the region which he had assisted to explore in Gregory's expedition. The succeeding popular arrangement by the bark divides them into six primary sections, the Latin characters of which will need translation before they can well be used by the colonists.

On some Tuberiform Vegetable Productions from China; by the Rev. M. J. Berkeley.—One of these *Fungi* (if such these apparently structureless rounded bodies are), the *Pu-foo-ling* of the Chinese, known immemorially in the northern part of China, where it is largely used as a drug and an esculent—and which was also described by Lourciro—proves to be identical with the *Tuckahoe* or Indian-bread of the Atlantic United States (*Lycoperdon solidum*, of Gronovius in Clayton's Flora Virginica, *Sclerotium Cocos* of Schweinitz, *S. giganteum* of Torrey, the *Pachyma Cocos* of Fries); thus adding another to the long list of species peculiar or nearly so to China or Japan and to the eastern side of North America.

Mr. Berkeley states that Tuckahoe has been analyzed by Prof. Ellet, and "ascertained to consist entirely of pure pectine of Braconnot. It is quite insoluble in water, though it dissolves in alkaline solutions, forming neutral pectates, whence the pectic acid is separated by the addition of muriatic acid, in the form of a colorless jelly: ..... This jelly may be prepared so as to form an agreeable article for the dessert."

We have not at hand the Gardener's Chronicle for 1848, referred to by Mr. Berkeley, in which the late Professor Ellet's account is probably cited. But we will at once reclaim the discovery and the original publication of these particulars for Professor Torrey, who, we may say, discovered that Tuckahoe was composed of pectine before pectine was itself discovered by Braconnot. Prof. Torrey's original paper upon the subject was read before the Lyceum of Natural History, New York, in the year 1819, and was published in the N. Y. Medical Repository for December, 1820; in this, after chemically ascertaining the properties of the substance, as since recognized, he adds that, "having shown that this principle differs from all those before described, it must be considered as a new species, and may be called *Sclerotin*." In 1827, after the publication of Braconnot's paper upon pectic acid, Dr. Torrey republished his earlier paper, with some additions, in the New York Medical and Physical Journal (vol vi, No. 4), and showed the identity of the two substances. Moreover, he criticised,—it is still thought with good reason,—the characters assigned by Braconnot to pectic acid, being unable to detect any acid properties in the Tuckahoe itself, and attributing the acid reaction of the so-called pectic acid, as prepared, to some of the muriatic acid employed for coagulating the solution being entangled in the jelly so completely that it could not be removed by the most copious washing, even with alkali. And Braconnot's so-called salts of pectic acid were suspected to be mere mixtures of the sclerotin with the alkali employed to dissolve it, and entangled in the substance when the jelly was formed. Inasmuch as Prof. Torrey's experiments and publications were perfectly well known to the late Prof. Ellet, it seems probable that they were duly referred to in his own publication. If not, they certainly should have been.

Notes on Abuta, a genus of Menispermeæ; by Prof. Grisebach of Gottingen; correcting its characters and limitation, and reducing to it *Anelasma* of Miers.

Notes on Arctic Plants, by Prof. Dickie of Belfast.

No. 11, issued early in the present year, contains several articles; of which much the longest and most important is Dr. F. Müller's paper on *Australian Acaciæ*, with annotations by Mr. Bentham. A note on the *Morphology of the Balsaminaceæ*, by Prof. Henfrey, promises no small interest, but the present number closes with its mere commencement.

A. G.

3. Walpers, *Annales Bot. Systematicæ;* continued by Dr. C. Mueller.—Vol. IV, the first of the continuation, closes with the *Begoniaceæ*, —a full abstract of Klotzsch's well-known memoir. These details were the less needed, inasmuch as the order is now printing in DeCandolle's Prodromus. The first fasciculus of the fifth volume, issued at the close of the past year, carries on the work from the *Passifloreæ* to the Eupatorineous *Compositæ*. This is a very useful compilation, but not remarkably

well planned. The bare index to the 215 species of *Mesembryanthemum* figured by Salm-Dyck is contrived so as to occupy rather more than four pages. A. G.

4. *On Parthenogenesis;* by E. REGEL, (Bot. Zeitung, Oct. 8, 1858, and a translation by Henfrey in Ann. and Mag. Nat. Hist., Feb. 1859).—Mr. Regel stoutly denies vegetable parthenogenesis altogether; but some of his objections are those of a special pleader rather than of an investigator, such especially as his remarks upon the case of *Cœlebogyne*. He records, however, some new observations upon *Spinacia* and *Mercurialis*, upon female plants of which, after strongly cutting them in, he finds male flowers constantly developed, which without great care would have escaped notice; whence he concludes that the results obtained by Naudin and Decaisne are valueless. He thinks he might find imperfect anthers upon female plants of *Cœlebogyne!* It is to be hoped that he will have the opportunity of searching for them; also that the French botanists will repeat his experiments upon *Mercurialis*, &c. But how does Regel reach the conclusion if an embryo may in certain cases be developed when fecundation is prevented then stamens are wholly superfluous structures? As, on the one hand, there is considerable reason to suspect that hermaphrodite plants continuously self-fecundated would after a while become sterile and so verge to extinction, so, on the other, sexual fecundation may be strictly necessary to the perpetuation of the species, without being strictly indispensable for every generation. And if there really be parthenogenesis in plants (and the evidence still seems to show that there is), then it is not likely to be restricted to two or three special cases, nor to diœcious species; but it is probable that some of the seeds in ordinary fruits, especially in polyspermous ones, are sometimes perfected without fecundation. *Natura non facit saltum.* A. G.

5. *Notices sur l'Amelioration des Plantes par le Semis, et Considerations sur l'Hérédité dans les Vegetaux,* &c.; par M. LOUIS VILMORIN. Paris, 1859, 8vo pamphl., pp. 64.—This very interesting pamphlet is a collection and reprint of several of Louis Vilmorin's important communications to the Central Agricultural Society of France and to the Academy of Sciences; to which is prefixed a French translation of a memoir upon the Amelioration of the Wild Carrot, contributed by his venerable father to the Transactions of the London Horticultural Society (but not before published in the vernacular of the author), which memoir, as the younger Vilmorin informs us, was the point of departure for his own investigations in this field, and even contains the germ of most of the ideas which he has since developed upon the theory of the amelioration of plants from the seed. These papers claim the attention of the philosophical naturalist, no less than of the practical horticulturist.

Most of our esculent plants are deviations from the natural state of the species, which have arisen under the care and labor of man in very early times. New varieties of these cultivated races are originated almost every year, indeed; but between these particular varieties, the differences, however well marked, are not to be compared for importance with those changes which the wild plant has generally undergone, in assuming the esculent state. In this amelioration or alteration, as in other cases, *c'est la premiere pas que coûte.* For the altered race, once origin-

ated, has much less stability than the wild stock; it accordingly tends, not only to *degenerate* (as the cultivator would term it) towards its original and less useful state, but also to *sport* into new deviations, in various directions, with a freedom and facility not manifested by its wild ancestors. This explains the readiness with which we continually obtain new varieties of those esculent plants which have been a long time in cultivation, while a newly-introduced plant exhibits little flexibility. To detect the earliest indications of sporting, and to select for the parents of the new race those individuals which begin to vary in the requisite direction, is the part of the scientific cultivator. In this way, the elder Vilmorin succeeded in producing the esculent carrot from the wild stock in the course of three generations,—no addition to our resources, indeed, but significant of what may be done by art directed by science. By adopting and skillfully applying these principles, the younger Vilmorin has conferred a benefit upon France which (if she will continue to make sugar from the beet) may almost be compared with that of causing two blades of grass to grow where only one grew before, having, so to say, *created* a race of beets containing twice as much sugar as their ancestors, and indicated the practicability of its perpetuation. The mode of procedure, and the ingenious methods he contrived for rapidly selecting the most saccharine out of a whole crop of beets, as seed-bearers for the next season, are detailed in these papers.

Once originated, and established by selection and segregation for a few generations, the race becomes fixed and perpetuable in cultivation, with proper care against intermixture, in virtue of the most fundamental of organic laws, viz., that the offspring shall inherit the characteristics of the parent,—of which law that of the general permanence of species is one of the consequences. The desideratum in the production of a race is, how to initiate the deviation. The divellent force, or idiosyncracy, the source of that "infinite variety in unity which characterizes the works of the Creator,"—though ever active in all organisms, is commonly limited in its practical results to the production of those slighter differences which ensure that no two descendants of the same parent shall be just alike, being overborne by that opposite or centripetal force, whatever it be, of which ensures the particular resemblance of offspring to parents. Now the latter force, as Mr. Louis Vilmorin has well remarked, is really an aggregation of forces, composed of the individual attraction of a series of ancestors, which we may regard as the attraction of the type of the species, and which we perceive is generally all-powerful. There is also the attraction or influence of the immediate parent, less powerful than the aggregate of the ancestry, but more close, which ever tends to impress upon the offspring all the parental peculiarities. So, when the parent has no salient individual characteristics, both the longer and the shorter lines of force are parallel, and combine to produce the same result. But whenever the immediate parent deviates from the type its influence upon its offspring is no longer parallel with that of the ancestry; so the tendency of the offspring to vary no longer radiates around the type of the species as its centre, but around some point upon the line which represents the amount of its deviation from the type. Left to themselves, as Mr. Vilmorin proceeds to remark, such varieties mostly perish in the vast

number of individuals which annually disappear,—or else, we may add, are obliterated in the next generation through cross-fertilization by pollen of the surrounding individuals of the typical sort,—whence results the general fixity of species in Nature. But under man's protecting care they are preserved and multiplied, perhaps still further modified, and the better sorts fixed by selection and segregation.

Keeping these principles in view, Mr. Vilmorin concluded that, in order to obtain varieties of any particular sort, his first endeavor should be to elicit variation in any direction whatever; that is, he selected his seed simply from those individuals which differed most from the type of the species, however unlike the state it was desired to originate. Repeating this in the second, third and the succeeding generations, the resulting plants were found to have a tendency to vary widely, as was anticipated; being loosed, as it were, from the ancestral influence, which no longer acted upon a straight and continuous line, but upon one broken and interrupted by the opposing action of the immediate parents and grand parents. Thus confused, as it were, by the contrariety of its inherited tendencies, it is the more free to sport in various ways; and we have only to select those variations which manifest the qualities desired, as the progenitors of the new race, and to develope and fix the product by selection upon the same principle continued for several generations.

It is in this way that Mr. Vilmorin supposes cross-fertilization to operate in the production of new varieties; and even in the crossing of two distinct species, the result, he thinks, is rarely, if ever, the production of a fertile hybrid, but of an offspring which, thus powerfully impressed by the strange fertilization, and rendered productive by the pollen of its own female parent, is then most likely to give origin to a new race.

We cannot follow out this interesting but rather recondite subject in a brief article like this. But we are naturally led to enquire whether the history of those plants with which man has had most to do, and the study of the laws which regulate the production and perpetuation of domesticated races, may not throw some light upon the production of varieties in Nature; and whether races may not have naturally originated, occasionally, under circumstances equivalent to artificial selection and segregation. Some recent attempts which have been made in this direction we may hope to notice upon another occasion. A. G.

6. *Botanical Necrology for* 1858.—The list of botanists who have departed during the past year is a long one, and includes some most eminent names,—such as those of Brown and Bonpland, which have already been noticed in the pages of this Journal. The following are the principal:—

Dr. B. Biasoletto, of Trieste; died January 17, 1858, aet. 65. He was a local botanist of merit, and an investigator of the *Algæ* of the Adriatic.

Aimé Bonpland, the well-known companion of Humboldt in American travel, and ever since a resident of Paraguay. Died in the 85th year of his age, August 22, 1857, but his decease was not announced in Europe until after the close of that year.

Robert Brown, of London, long since styled by Humboldt *Botanicorum facile princeps:* died May 10, 1858, in the 85th year of his age.

Prof. G. A. Eisengrein, of Freiburg in Briesgau; died July 26, 1858.

H. Galeotti; a scientific traveller and well-known botanical collector in Mexico and Central America; died in April, aet. 44.

W. T. Gumbel, of Landau, Rhenish Bavaria; a distinguished bryologist, associated with Schimper in the publication of the later portions of the *Bryologia Europæa:* died Feb. 10, 1858, aet. 46.

Mrs. Loudon, the widow of *J. C. Loudon*, herself an able popular writer of works upon gardening and botany, and a person of remarkable ability, whose name may well claim a place in this list: died, near London, in July, 1858.

Prof. Ernest H. F. Meyer, of Königsberg: died, August 7, at a mature age. His earliest work, a monograph of *Juncus*, was published in 1819.

Prof. C. F. A. Morren, of Louvain, died, Dec. 17, 1858; aet. 52. His writings mainly relate to physiological matters.

Dr. J. B. Mougeot, of Bruyères, in Eastern France, a cryptogamist of considerable note: died, Dec. 5, 1858, aet. 82 years.

Prof. C. G. Nees von Esenbeck, long one of the most distinguished and productive botanists of Germany, and for almost half a century President of the old Imperial Society Naturæ Curiosorum: died March 16; aet. 82 years.

David Townsend, of West Chester, Pennsylvania, the life-long associate of the venerable Dr. Darlington, who has published an interesting memorial of his friend and companion in botanical pursuits. Dr. Darlington and Mr. Townsend have made the quiet borough of West Chester famous in botanical annals, and have set an example worthy of all imitation. Although not, like his distinguished associate, a botanical author, Mr. Townsend was an excellent and active local botanist, and was so skillful and tasteful in the preparation of dried specimens that Sir William Hooker associated his name with that of Professor Short of Kentucky, as preëminent in this important art. Mr. Townsend's name is commemorated in the genus *Townsendia*, of Hooker, peculiar to North America, now comprising six of seven species of humble but beautiful, Aster-like plants. The botanist whose name they will perpetuate died, Dec. 6, 1858, at the age of 71 years.

Dawson Turner, Esq., of Yarmouth, one of the oldest of British botanists, who so early as the year 1802 published his first work upon the British Fuci, died on the 20th of June, 1858, at the age of 83 years.

C. Zeyher, whose name with that of Ecklon, is so intimately associated with the botany of the Cape of Good Hope, which he has so extensively explored, died at the Cape, near the close of the past year.

A. G.

7. *Mammoth Tree of California—Sequoia gigantea.* (From an article by Dr. B. Seemann, Ann. Mag. Nat. Hist., [3], iii, 175).—The mammoth tree was introduced into European gardens by Mr. William Lobb; and in 1853 single plants were sold by Veitch's Nursery for £2 2s.; but since then quantities of seeds have been imported, and there is now hardly a horticultural establishment without one or more representatives of this remarkable evergreen. In England it seems to stand the winter without injury; and even in Germany and other parts of Northern Europe it does not require the protection of a glass house; so that even

in those countries it may become a forest- and useful timber-tree. In July 1856, complaints were heard that, in spite of the most careful culture, a peculiar disease had befallen this new *Sequoia*, in consequence of which the twigs were observed to die off in the same manner as they do in *Cryptomeria Japonica*. Horticulturists began to take alarm, and feared that their new acquisition would inevitably be lost; but Dr. Lindley soon discovered that, though the twigs died, the main stem and branches continued to grow vigorously, and that the so-called disease was constitutional, and could not be looked upon as a sign of ill-health, or a proof of bad culture. In 1858 it bore ripe fruit in England, under the skillful treatment of Mr. J. Buckle, at Thetford.

8. *Prodromus Descriptionis Animalium Evertebratorum, etc.* Invertebrates collected during the North Pacific Expedition under Captains Ringgold and Rodgers, U. S. N., and described by W. STIMPSON. Part VII.—Mr. Stimpson, in this paper, published in the Proceedings of the Academy of Natural Sciences of Philadelphia (Dec. 1858), continues his catalogue, notes and description of species of Crustacea from the North Pacific expedition. The number of species brought home by Mr. Stimpson was very large, and the new species alone exceed six hundred. Part VII contains the Anomoura. The collections in this tribe number 83 species; and with the help of extensive collections of the described species, he has been enabled to give the subject a careful revision. In the Dromia tribe he has instituted the new genera *Dromidia* (for *Dromia hirsutissima*, Lamk.), *Cryptodromia* (for *Dromia nodipes*, Lamk.), *Pseudodromia*, *Petalomera*, *Conchoecetes* (for *Cancer artificiosa* Herbst). The large genus *Porcellana* he has subdivided, apparently on good grounds, as follows:

A. *Antennarum externarum articulus primus brevis, marginem carapacis superiorem non attingens.*

PETROLISTHES, nov. gen. Carapax depressus, subovatus, non latior quam longior; fronte triangulari, margine plus minusve undulata, dentata vel integra. Oculi sat grandes. Antennarum pedunculus plus minusve cristatus. Chelipedes lati, depressi. Pedum ambulatoriorum dactyli normales, i. e. breves, sat robusti, unguiculo unico.—*Typus*, P. violaceus. *Porcellana violacea*, Guerin; Mag. de Zool., 1838, p. 5, pl. xxv, f. 2. *P. macrocheles*, Pœppig.—Chili.

PISOSOMA, nov. gen. Carapax rotundatus, sat convexus, non longior quam latior. Frons superne visa recta, integra. Chelipedes crassi. Dactyli pedum ambulatoriorum normales.—*Typus*, P. pisum. *Porcellana pisum*, M. Edw.; Hist. Nat. des Crust. ii. 254.—Mari Orientali.

B. *Antennarum externarum articulus primus plus minusve productus et margini carapacis junctus; articulus secundus orbitâ remotus.*

RAPHIDOPUS, nov. gen. Carapax rotundatus, latior quam longior. Frons non prominens, fere recta, tridentata. Oculi minuti. Pedum ambulatoriorum dactyli longi, recti, gracillimi compressi et acutissimi.—*Typus*, R. ciliatus, infra.

PACHYCHELES, nov. gen. Carapax rotundato-ovatus, non longior quam latior; epimeris postice solutis, parte posteriore quadrata, interstitio cutaneo disjuncta. Frons medio parum prominens, subacuta. Antennarum articulus primus minus productus. Chelipedes crassissimi, rugosi; carpo brevi. Pedum ambulatoriorum dactyli normales.—*Typus*, P. grossimanus. *Porcellana grossimana*, Guerin; Mag. de Zool. 1838, pl. xxvi, f. 8.—Chili.

MEGALOBRACHIUM, nov. gen. Carapax rotundatus, non longior quam latior. Frons augusta, laminata, parum prominens, fere recta. Oculi minuti. Chelipedes crassi, mero magno, manu brevi. Pedum amb. dactyli normales.—*Typus*, M. granuliferum, Stm.—Ins. Antillarum.

PORCELLANA, Lam'k, restrictum. Carapax plerumque longior quam latior, lateribus carinatus; epimeris integris. Frons sat lata, prominens, plus minusve dentata. Orbitæ profundæ. Antennarum articulus primus valde productus, intus acutus. Chelipedes sat depressi; carpo brevi, margine anteriore intus sæpius unilobato; digitis sæpius contortis. Pedum amb. dactyli normales, sat longi. *Typus*, P. platycheles, Lam'k; An. s. vert., v. 230.—Europa.

MINYOCERUS, nov. gen. Carapax angustus. Frons tridentata. Antennulæ longiores, articulo primo magno depresso, dentato. Antennarum articulus primus ei *Porcellanæ* similis; pars mobilis minuta, quadriarticulata, quam art. primus non longior. Chelipedes debiles. Pedum amb. dactyli normales.—*Typus*, M. angustus. *Porcellana angusta*, Dana; loc. cit. i. 428, pl. xxvi, f. 12.—Brasilia.

PORCELLANELLA, White. (Voy. Rattlesnake, ii. 394.) Carapax oblongus, multo longior quam latior, lateribus fere parallelis; lobulus gastricis obsoletis. Frons horizontalis, laminiformis, valde prominens, tridentata. Antennæ ei *Porcellanæ* similes. Chelipedes læves, carpo brevi, manu elongata. Pedes ambulatorii parvi, mero crasso, dactylis brevibus, uncinatis, compressis, multi-unguiculatis.—*Typus*, P. triloba, White; l. c., ii. 394, pl. v, f. 2.

POLYONYX, nov. gen. Carapax rotundato-ovalis, latior quam longior, convexus, lævis. Frons sat angusta, recta. Antennularum articulus primus non dentigerus. Antennarum articulus primus prælongus. Oculi minuti. Chelipedes læves; mero magno. Pedum amb. dactyli brevissimi, lati, intus bi- vel multi-unguiculati. *Megalobrachio* affinis, dactylis exceptis.—*Typus*, P. macrocheles. *Porcellana macrocheles*, Gibbes; Proc. Am. Assoc. 1850, p. 191.—Carolina.

A list of all known species pertaining to each of these proposed genera is added, after much careful study of specimens.

Under the Hippidæ there is the new genus *Mastigopus*, and under Albunidæ, *Lepidopa*. Among the Lithodea, the *Lithodes hystrix* of De Haan is referred to the new genus *Acantholithus*. Among the Paguridea, there are the new genera *Petrochirus* (for the *Pagurus granulatus* Oliv., M. Edw.), *Isocheles* (for the *Bernhardus æquimanus* Dana), and *Spiropagurus* (for the *Pagurus spiriger* De Haan).

9. *Memoires pour servir a l'Histoire Naturelle du Mexique, des Antilles et des États-Unis;* par HENRI DE SAUSSURE. Première livraison, *Crustacés nouveaux du Mexique et des Antilles.* 4to pamph. pp. 80 and 6 plates. Geneva, 1858.—The materials for this work were collected by the author himself during his visit to America. The Mexican Crustacea are all from the eastern or Gulf shores. There are in all fifty-six species described, forty-nine of which are believed by the author to be new. Besides these, as is stated in the preface, several probably new species were collected, about which the author could not be certain, for want of access to books and collections;—a want certainly unfortunate, as it seems to have caused M. de Saussure to fall into some errors regarding what he did venture to publish. At the present day it will be found highly desirable for those writing upon subjects connected with American zoology, to consult the works of American naturalists. In the case before us for instance, a knowledge of the carcinological writings of Say and Gibbes would have enabled the author to have rendered his work more accurate, and saved him some labor.

In the preface Mr. de Saussure gives some interesting general remarks, including details confirmatory of the principle first pointed out by Prof. Dana,—that Crustacea attain their maximum of development in the temperate, and not as with other Articulates, in the tropical zone. He is in error, however, in asserting that the "langouste" (*Palinurus*) inhabits the latitude of Philadelphia and New York.

The diagnoses of most of the species were published in the *Revue Zoologique* for the year 1857. In that journal two new genera were described; *Pseudotelphusa*, which Mr. de Saussure now considers identical with *Potamia* (*Boscia*); and *Halopsyche*, referred to Gebiens, which is now acknowledged to be *Alpheus*. In fact *Halopsyche luturia* is closely allied if not identical with *Alpheus heterochelis* of Say. In describing new species it is always a great aid to their subsequent recognition, to mention those forms to which they most approximate in character, and if closely allied, to indicate the differences. But the author even when describing species apparently identical with previously described ones well known in this country, neglects to make such comparisons.

We should scarcely have ventured upon the following criticisms were it not for the excellent figures which adorn the work, and enable us to recognise several of the species with considerable certainty. The author has failed to apply some of the recent improvements in the science, neither De Haan's subdivision of *Lupa* nor Dana's of *Pagurus* being adopted, while more doubtful Parisian novelties of classification, as in *Grapsus*, are fully recognised. *Pericera bicornis* De S., seems to be very near to *P. bicorna* (Edw.) Gibbes; if distinct it should certainly receive a more diverse name. *Lambrus crenulatus* is interesting as being the first species found on the American shores, of a genus so abundantly represented on those of the old world. *Chlorodius americanus* seems to be one of the numerous varieties of *C. floridanus* Gibbes. Three new species of *Panopeus* are described, *P. occidentalis*, *serratus*, and *americanus*, from Guadeloupe, all closely allied to *P. Herbstii*, (with which they should have been compared,) but apparently distinct. We have specimens of *P. serratus* from Florida. The genus *Portunus* is new to our waters; the author describes one species, *P. guadulpensis* (guadelupensis?). The three species referred to Milne Edwards' genus *Metopograpsus* will not probably fall into that group; at any rate *M. dubius* De S., is identical with *Pachygrapsus transversus* Gibbes, a common West Indian species, and the other two species seem to be closely allied, and also referable to *Pachygrapsus*. In the *Metopograpsi*, an East Indian and Pacific group, the internal suborbital lobe is joined to the front. *Plagusia gracilis* appears to be a good species, differing from *P. Sayi* in the quadrilobate margin of its epistome. *Hepatus tuberculatus* De S. should be compared with the young of *H. decorus*. *Remipes cubensis* is a good species, characterized by the marginal band of lineolæ uninterrupted by a longitudinal sulcus. We had almost simultaneously indicated this species as *R. barbadensis*, it being the *Squilla barbadensis ovalis* of Petiver. *Pagurus cubensis* De S. is probably *Clibanarius sclopetarius*, as the characters agree except in one point;—it is said of the feet that "La première paire atteint un peu au delà du milieu du troisième article de la deuxième paire." We presume however that the author means the third of those joints which project from beneath the carapax. *Caridina mexicana* would be more properly referred to *Atyoida*, for in *Caridina* the second pair of feet have a long slender carpus not bifurcated at the extremity. (See M. Edwards; Hist. Nat. des Crust., pl. 25[bis], f. 4.) Seven new *Palemons* are described, which we should have judged to be freshwater species, but our author says that they, as well as *P. jamaicensis*

are found on the coasts. Of Tetradecapoda twelve species are described, —one *Amphitoe*, seven *Porcellios*, one *Armadillo*, one *Pseudarmadillo*, (a new genus between *Armadillo* and *Armadillidium*,) one *Anilocra*, and one *Cymothoa*. The only Entomostracan is *Chlamydotheca azteca*, of a new generic type forming a subdivision of the old genus *Cypris*.

W. S.

10. *Observations on the Genus Unio;* by ISAAC LEA, LL.D.—In our notice of Dr. Lea's Memoir we stated that the embryonic form of the shell in the case of 38 species of Unionidæ is figured without details on one of the plates. We intended to say without details on the plates. There are detailed descriptions occupying eight pages of the memoir.

11. *Catalogue of the Described Coleoptera of the United States;* by FRIEDRICH ERNST MELSHEIMER, M.D., revised by S. S. HALDEMAN and J. LECONTE. 174 pp. 8vo.

12. *Catalogue of the described Diptera of North America;* prepared for the Smithsonian Institution by R. OSTEN SACKEN. 92 pp. 8vo.

These two works were issued the past year by the Smithsonian Institution. They are of great value to all interested in these departments of Entomology.

IV. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Appendix to the Article on Fluctuations of the Water Level of the Lakes* (p. 305); by C. WHITTLESEY. (Received too late for insertion in connection with the article.)—Since this article was written I have seen the following notices of the discovery of a lunar tide on Lake Michigan, by gentlemen who have made observations at Milwaukee and at Chicago.

"It may not be improper for me to add, that very numerous observations have been made here to ascertain the character of the fluctuations of the level of Lake Michigan, one of the results of which was announced by me in the Milwaukee Daily Sentinel & Gazette, of Sept. 3d, 1849, in the following words:

'*An Important question settled.*—By a series of observations made every three hours during the month of August, 1849, I have ascertained that there *is a slight lunar tide on Lake Michigan.*'

Other subsequent observations made *hourly both day and night*, for two months, fully confirmed this conclusion. I. A. LAPHAM.

Milwaukee, Dec. 24th, 1858."

At a meeting of the Chicago Historical Society, Nov. 30th, 1858, I find among the proceedings the following report:

"An interesting announcement was made at this meeting by Lieut. Col. J. D. Graham, U. S. A., of the recent discovery of the operation of lunar attraction upon the waters of Lake Michigan.

A series of accurate tidal observations has, during the last four years, been prosecuted under the superintendence of Col. Graham, resulting in the discovery above noticed. The supposed influence is more noticeable at the period of the moon's conjunction or opposition, and in tranquil weather, the observed extent of it being about two-tenths of a foot.

The brief announcement by Col. Graham will, it is hoped, be followed by a detailed statement of facts and data at a future day."

2. *Report on the History and Progress of the American Coast Survey up to the year* 1858, by the Committee of twenty appointed by the American Association for the Advancement of Science at the Montreal meeting, August, 1857. 88 pp., 8vo.—The committee of twenty appointed by the Association, consisted of Judge J. K. Kane, Pres. Amer. Phil. Soc. Pa., Gen. J. G. Totten, Chief Engineer U. S. A., Prof. Benjamin Peirce, Harvard College, Mass., Prof. John Torrey, U. S. Assay Office, N. Y., Prof. Joseph Henry, Sec. Smithsonian Institution, D. C., Prof. J. F. Frazer, University of Pennsylvania, Pa., Prof. Wm. Chauvenet, U. S. Naval Academy, Md., Pres. F. A. P. Barnard, University of Mississippi, Miss., Prof. John Leconte, College of South Carolina, S. C., Prof. Wm. M. Gillespie, Union College, N. Y., Prof. F. H. Smith, University of Virginia, Va., Prof. W. H. C. Bartlett, U. S. Military Academy, N. Y., Prof. Wolcott Gibbs, Free Academy, N. Y., Prof. Stephen Alexander, College of New Jersey, N. J., Prof. Lewis R. Gibbes, Charleston College, S. C., Prof. Joseph Winlock, Sup. Am. Alm., Ky., Prof. James Phillips, University of North Carolina, N. C., Prof. Wm. Ferrel, Nashville, Tenn., Prof. Edward Hitchcock, Amherst College, Mass., Prof. James D. Dana, Yale College, Conn. After the death of Judge Kane in February, 1858, Pres. F. A. P. Barnard was appointed chairman of the committee.

The Report treats of the methods of coast survey in different countries, the history of the Coast Survey in this country, the results up to 1858, and the benefits to navigation, commerce, and general science. We have presented in a recent article a review of some of these results. This Report gives a broader and fuller exposition of the whole subject, and exhibits in a strong light the indebtedness of the country to the ability and excellent management of Prof. Bache, the Superintendent. It is only necessary to cite here from the concluding pages of the Report the recapitulation of the conclusions concurred in by "the Committee with entire unanimity."

"1. The American Coast Survey, in its inception, was a work imperatively demanded by a due regard to the industrial interests of the country, dependent, as they are, greatly upon the prosperity of commerce for their free development.

2. The indecision which marked the early policy of the government in regard to this Survey, and the consequent delay of its efficient operations, and postponement of its beneficial results, were of manifest disadvantage to the material welfare of our people, and cannot but be still subjects of serious regret.

3. The economical value of such surveys is attested by the universal voice of all commercial men, and by the concurrent practice of all commercial nations, no less than by the melancholy records of marine disaster annually occurring upon every unexplored coast.

4. Their scientific value is witnessed, in the instance of the American survey, by the spontaneous tributes of approval frequently and freely bestowed upon it—no less in regard to the ability, energy and skill displayed in its management, than to the magnitude, variety, and oftentimes curious interest of the results it has wrought out—by individuals and organized bodies of men, whose high position as scientific authorities renders their opinions upon subjects of this nature entirely conclusive.

5 This work has conferred many valuable benefits upon science, indirectly and incidentally, in the invention or perfection of instruments, in the improvement of methods of observation or of computation, in the development it has given to special subjects of interesting inquiry, and in the stimulus which it has furnished to the scientific talent of the country, especially in the field of astronomical observation and investigation.

6. A careful study of the progress made from year to year, especially since the enlargement of the scale of operations under the present superintendent, affords ample evidence that the work has been expeditiously prosecuted, and the amount accomplished up to the present date is materially greater than has ever been accomplished in any other country in the same length of time, and with the same means.

7. Compared with the same surveys executed or in progress of execution by foreign governments, the American survey has been conducted with remarkable economy.

8. Compared with such foreign surveys, the quality of the work done in this will bear the test of any standard that has ever been anywhere set up, and is such as to reflect honor on the scientific character of our country in the eyes of the world.

9. Every consideration of economy, of humanity, and of regard for the reputation of the country, demands that the work should be prosecuted with undiminished activity, until every portion of our coast shall have been as thoroughly explored and mapped as those have been already in which its operations commenced.

10. Conclusive reasons, involving other weighty public interests no less than this, but connected also with the project of verifying in the happiest manner the geodesy of our extended and circuitous coast, conspire to render the triangulation of the great Appalachian chain of mountains a most desirable undertaking, and encourage the hope that our government will very early direct that most important work to be executed.

11. The publication in full of all the observations upon which the published results of the Coast Survey are founded, together with the methods employed in the reduction and discussion of the observations, would be a contribution to science, and especially to the science of geodesy, of inappreciable value, besides being necessary to secure the records against loss; and the committee earnestly hope that the government may not fail to provide the means for the adequate and rapid prosecution of the work.

12. The existing organization of the Survey, judged in the light of the experience acquired by our own and by foreign governments in the management of such works, is, in the deliberate opinion of the committee, preferable to any other that has ever been suggested."

3. *Note on the Height of the Atmosphere.*—A letter from Mons. Emm. Liais published in the *Comptes Rendus* (Jan. 10, 1859, p. 109) gives the results of his inquiries into the height of the atmosphere as deduced from observations on polarization made at the tropics at the commencement of dawn and the end of twilight. The letter is dated San Domingos, Bay of Rio Janeiro, Dec. 6, 1858. His observations at that place, Dec. 1, 2, and 3, indicated that the limit of atmospheric polarization was 9^m 40^s in passing from 20 degrees east of the zenith to 20 degrees west. But at San Domingo, of which the latitude is 23° S., the limit of the

shadow passes over 25·6 kilometres per minute, or 247·5 kilometres in $9^m 40^s$. From this the height of the atmosphere is calculated to be 340 kilometres or 211 miles.

4. *Museum of Comparative Zoology at Cambridge.*—Since our last (see pp. 295–299 this vol.) a new and most encouraging aspect has come over this important movement. The legislature of Massachusetts, after listening to the persuasive eloquence of Agassiz, exhibiting in the most catholic and unselfish spirit the claim of the subject upon the public purse, has appropriated one hundred thousand dollars for a zoological museum, on the condition that as much more should be subscribed, including the legacy of Mr. Francis C. Gray of \$50,000, for the same purpose. The subscription soon amounted to \$80,000 besides this legacy, or in all, including the bounty of the State, to the magnificent sum of \$230,000 (*two hundred and thirty thousand dollars*). It is now proposed to make up the whole amount to a quarter of a million.

It will be remembered that the legacy of Mr. Gray is for the expenses of the museum exclusive of salaries or buildings.

This bounty of the State is derived from the sales of a large tract of land in the city of Boston reclaimed by the commonwealth from the "*Back Bay,*" and hence called the "*Back Bay lands.*" The whole proceeds of this noble domain so far as by partition with the city and the contractors they belong to the State (and they are estimated by millions) are solemnly dedicated to the cause of education—ever held most sacred in great-hearted Massachusetts. Were it pertinent to our pages we should delight to transfer to them all that relates to this subject, but we will content ourselves by giving the act of incorporation for the "*Museum of Comparative Zoology*, passed April 6, 1859."

"An act to incorparate the Trustees of the Museum of Comparative Zoology:

Be it enacted by the Senate and House of Representatives in General Court assembled, and by the authority of the same, as follows:

Section 1. The Governor, the Lieutenant Governor, the President of the Senate, the Speaker of the House of Representatives, the Secretary of the Board of Education, the Chief Justice of the highest Judicial Court, *ex officiis*, and Louis Agassiz and William Gray, together with Jacob Bigelow, James Walker, George Ticknor, Nathaniel Thayer, Samuel Hooper, Samuel G. Ward and James Lawrence, and their successors, are hereby made a body politic and corporate, by the name of the 'Trustees of the Museum of Comparative Zoology,' with all the powers and privileges set forth in the Forty-fourth Chapter of the Revised Statutes, so far as the same are applicable to the purpose for which said Corporation is established, as hereinafter mentioned, and not inconsistent with the provisions of this Act.

Section 2. Said Corporation may receive, hold, purchase and possess real and personal property not exceeding three hundred thousand dollars in value, to be used and improved for the erection, support and maintenance of a Museum of Comparative Zoology at Cambridge, in this Commonwealth; and the sum of fifty thousand dollars, heretofore contributed in aid of the Museum of Comparative Zoology by William Gray, shall be deemed to be a part of the sum required to be raised by private subscription for the said Museum, as a condition precedent to the payment by the Commonwealth to said Trustees of any part of the avails of the sales of land in the Back Bay.

Section 3. The places of Louis Agassiz and William Gray, whenever the same or either of them shall become vacant by death, resignation or otherwise, shall be filled by a concurrent vote of the Senate and House of Representatives, and the

same course shall be afterwards adopted when the place of the successor of either of them shall become vacant; but any vacancy occasioned by the death, resignation or otherwise, of any of the other persons named in this Act (except the members designated *ex-officiis*), or of the successors of such persons, shall be filled by election by the whole board of Trustees, at meetings specially called for that purpose.

SECTION 4. The said Trustees shall arrange, so far as may be done consistently with the interests of the institution, for the distribution of duplicate specimens, by exchange or otherwise, among other colleges and institutions of learning in this Commonwealth and elsewhere. And the Museum belonging to said Trustees shall, at all reasonable times, and under reasonable regulations, be kept open to the public free of charge.

SECTION 5. This act shall take effect from and after its passage."

5. *Conservatory of Art and Science.*—By force of that "perpetual semination" which Lord Bacon says is ever the surest sign of a great principle, Agassiz's example has awakened, it seems, in the whole body politic in Massachusetts a noble zeal to secure for the citizens of the whole State a truly National Museum, on the broad plan of the British Museum, or rather, it is said, to unite the features of the Paris Garden of Plants with the *Conservatoire des Arts et Metiers*, to be located at Boston and endowed and sustained by the public purse. This movement promises to be successful as soon as a proper plan is matured. The Committee on Education commended it to the legislature in the strongest manner, and only certain considerations of a private nature between the City of Boston and the Commonwealth prevented its taking the form of law a month ago. The source of endowment is to be also the Back Bay lands. The spirit of Boston and its commonwealth is adequate not merely to conceiving, but to giving practical efficiency to any plan for a great public museum which the wisdom of its citizens may elaborate; for there, is ever found the happy union of the designing mind and the executive hand—the ability both to *say* and to *pay*.

6. *Legacy to Yale College, New Haven.*—The bequest of the Hon. Henry L. Ellsworth to Yale College, amounting, it is estimated, to two or three hundred thousand dollars, is appropriated by the will to scholarships, and is therefore rather a gift to the public than to the College itself. The will is to be contested and the issue is doubtful. If sustained, the College will receive from it only tuition fees, and these, as is well known, meet but little more than half the expenses of instruction. It is a munificent donation to the general interests of public education.

7. *Journal of the American Geographical and Statistical Society.*—The American Geographical and Statistical Society of New York has commenced the publication of a monthly Journal of thirty-two large octavo pages. The enterprise is important and deserving of hearty encouragement. We wish it complete success.

The object of the Journal, as stated in the introduction, is to furnish information on Geographical and Statistical subjects, by the publication, in a form adapted to their preservation and convenient use, of the papers read before it, and of communications with which it may be favored; to cultivate and cherish a taste for research in the wide field of Geography and Statistics; and to create among its members an interest that will secure their hearty co-operation in the promotion of its objects. In the absence, both in the Federal and State Governments, of bureaus specially devoted to these subjects, a work similar in character to the one now presented seems indispensable to their proper elucidation and publication.

OBITUARY.—Prof. WILLIAM W. MATHER, acting President of the University of Ohio at Columbus, died in that city, February 26, 1859. He was graduated at the U. S. Military Academy in 1828—where he continued to reside as instructor in mineralogy and geology, and assistant to the professor of chemistry until 1834–5. In 1836 he resigned his commission in the army and devoted himself exclusively to scientific pursuits. Being appointed by the Governor of New York one of the four principal geologists for the survey of that state, his final report on the geology of the first district was published in a large quarto in 1843. This was his most important original work—and it will always bear honorable testimony to his ability and accuracy as an observer in this department of nature. He held the post of geologist to the state of Ohio from 1837 to 1840, and published three annual reports of which notice will be found in the first series of this Journal. He was also for a time charged with a geological reconnoissance of the state of Kentucky and published one preliminary report on that state. Since 1842 he has been connected as an instructor with the University of Ohio. His contributions to the pages of this Journal have been numerous and important both in chemistry, mineralogy and geology. His paper, entitled "Contributions to Chemical Science," printed in vol. XXVII, first series (1835), gives ample evidence of his ability in practical chemistry. His age is not reported; but he could not have been far from fifty-five years. He was a native of Middlesex county, Connecticut.

Proceedings of the American Association for the Advancement of Science. 12th meeting, held at Baltimore, May, 1858. 820 pp. 8vo. Cambridge, J. Lovering.

United States Exploring Expedition, during the years 1838, 1839, 1840, 1841, 1842, under the command of C. Wilkes, U.S.N.—Mammalogy and Ornithology. By J. Cassin. 4to. VIII, 466 pp. With a Folio Atlas of 53 plates. *Philadelphia,* 1858.

W. BUCKLAND: Geology and Mineralogy considered with reference to Natural Theology. New edit., with Additions by Owen, Phillips, Rb. Brown, and Memoir of the Author. Edited by Fr. T. Buckland. 2 vols. *London,* 1858. 8°. 760 pp.

JOURN. ACAD. NAT. SCI. PHILAD., Vol. VI, Part I.—96 pages 4to, with 20 plates.

PROCEEDINGS ACAD. NAT. SCI. PHILAD. 1859.—p. 1, Note on some tribes of Western Africa; *P. B. Duchaillu.*—p. 3, New species of Pomotis; *Morris.*—Fossil Fishes of the Carboniferous of Kansas; *J. Leidy.*—p. 4, New species of Tortoises; *J. Le Conte*—p. 8, Geol. Expl. in Kansas; *Meek* and *Hayden* (this vol. p. 424).—p. 30, Birds of Western Africa; *J. Cassin.*—p. 56, Ichthyological Notices; *C. Girard.*—p. 69, Catalogue of the Coleoptera of Fort Tejon, California; *J. L. LeConte.*

PROCEEDINGS BOSTON SOC. NAT. HIST. Vol. VI.—p. 400, Description of some Insects; *S. S. Haldeman.*—p. 404, Note on parasites of Orthagoriscus mola (Sun-Fish); *J. C. White.*—p. 407, Notes on Fishes; *Agassiz.*—p. 409, Decomposition of sesquioxyd of chromium, by caustic alkali; *C. T. Carney.*—p. 410, On the forms of Birds; *T. Lyman.*—p. 411, On the Discoboli; *Agassiz.*—New genus of Crustacea between Pinnotheres and Hymenosoma, called Hapalocarcinus; *W. Stimpson.*—p. 414, Note on temperature of ocean limiting the geographical distribution of species; *Agassiz.*—p. 416, Report on Dr. I. I. Hayes's proposed expedition to the North Pole.—p. 418, On the N. A. species of Mustela; *Kneeland.*—p. 418, On European species of Salmo found in America; *Agassiz.*—p. 422, Land Shells of the N. Pacific Expedition; *A. A. Gould.*—p. 426, On the mechanism of the flight of Lepidoptera; *Agassiz.*—p. 428, Stephanurus dentatus of Diesing; *J. C. White.*—p. 428, On the breathing apparatus of Menobranchus; *Kneeland.*

Vol. VII. March, 1859.—p. 1, On the power of larves of eating flesh poisoned by arsenic; *F. H. Storer.*—p. 3, Notes on some Fishes; *Putnam.*—p. 5, Birds of East Florida.

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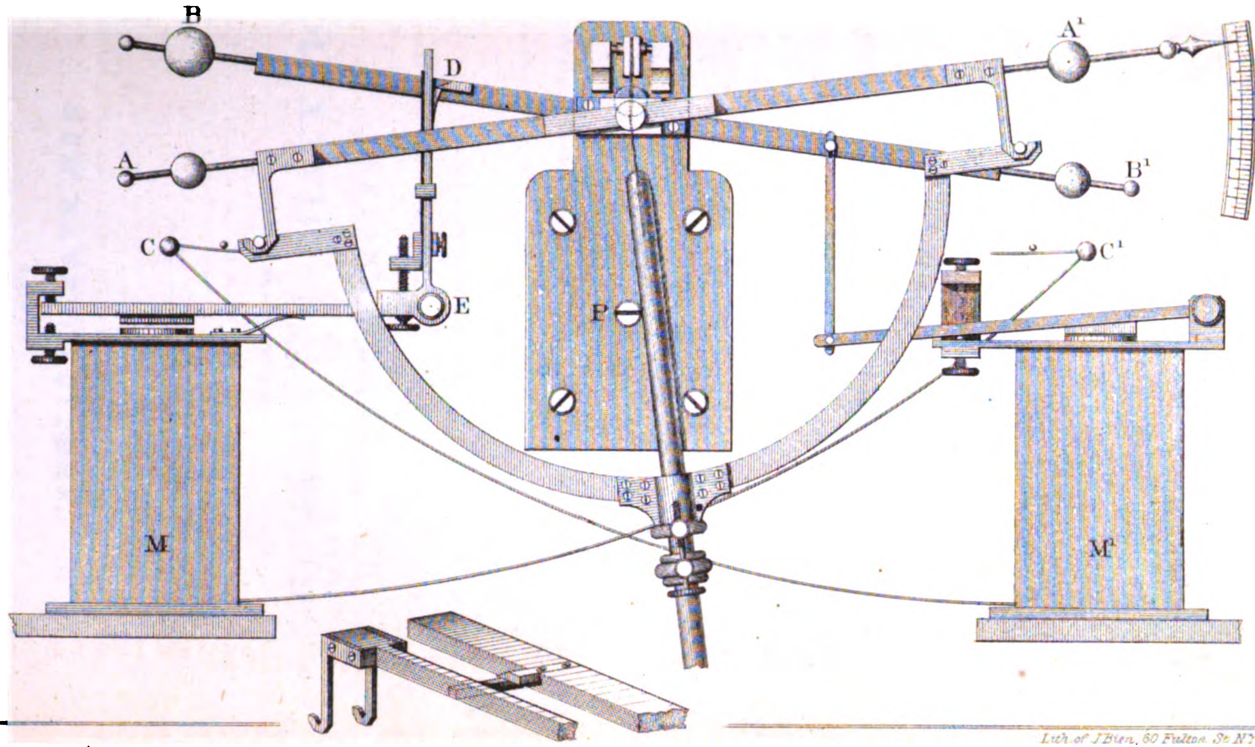
DIAGRAM OF AN ELECTRICAL CLOCK DESIGNED BY PROF F A P BARNARD



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THE

AMERICAN JOURNAL

OF

SCIENCE AND ARTS.

CONDUCTED BY

PROFESSORS B. SILLIMAN, B. SILLIMAN, JR.,

AND

JAMES D. DANA,

IN CONNECTION WITH

PROF. ASA GRAY, OF CAMBRIDGE,
PROF. LOUIS AGASSIZ, OF CAMBRIDGE,
DR. WOLCOTT GIBBS, OF NEW YORK.

SECOND SERIES.

VOL. XXVIII.—NOVEMBER, 1859.

WITH A PLATE AND MAP.

NEW HAVEN: EDITORS.
1859.

E. HAYES, PRINTER.

CONTENTS OF VOLUME XXVIII.

NUMBER LXXXII.

SCIENTIFIC INTELLIGENCE.

NUMBER LXXXIII.

SCIENTIFIC INTELLIGENCE.

NUMBER LXXXIV.

SCIENTIFIC INTELLIGENCE.

ERRATA.

Page 236, line 1, for "lightly," read "slightly."
" 236, " 7, insert "*side is a,*" between "other and branch."
" 240, insert specific name, "grandis," after "Actinocrinus."
" 240, line 15, for "obscure," read "obscurely."
" 241, " 2 from bottom, for "oval," read "oral."
" 244, " 14, for "armbones," read "umbones."
" 244, " 9 from bottom, for "cyclostomus," read "Cyclostomus."
" 248, " 25, for "p. c." read "oz."
" 249, " 37, for "G. J." read "J. P."
" 252, " 27, for "$\frac{1}{4}$," read "$\frac{1}{8}$."
" 353, " 14 from bottom, for "3·8924+121·80," read "3·8924×121·80."
" 253, " 10 from bottom, for "4·6440+121·80," read "4·6440×121·80."
" 291, bottom, for "ENGLEMANN," read "ENGELMANN."
" 403, (in some copies) 8 lines from bottom, for "ANDREAS," read "ANDRAS."

THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. I.—*On a new Sounding Apparatus for Deep-sea Sounding;* by Prof. W. P. TROWBRIDGE, Assistant U. S. Coast Survey.—With a Plate.

[Published in this Journal by permission of the Treasury Department.]

Communication addressed to Prof. A. D. BACHE, Supt. U. S. Coast Survey, dated U. S. Coast Survey Office, Washington, D. C., April 6, 1859.

Dear Sir,—In my report to you of May 31, 1858, I had the honor of presenting the results of an investigation of the laws of descent of heavy bodies in the ocean, under the conditions required in deep-sea sounding.

The object of that investigation was to ascertain and develop fully the causes of failure and error in deep-soundings, and to devise a more certain and reliable mode of measuring the depth of the ocean, in the off-shore hydrography of the Coast Survey, and especially in the swift current of the Gulf Stream.

I have now to present for your further consideration a sounding apparatus based upon the developments given in my former report, and the result of further study and experiments on the subject.

The distinguishing feature of the method herein described, though exceedingly simple in its application, has never before been proposed, inasmuch as its necessity could hardly have been felt, without a careful analysis of the circumstances of descent of the sounding lead and line.

In the method of sounding heretofore employed, the influence of the friction of the water upon the line, or "endwise resist-

ance" as it is called by Prof. Airy, was known to exist, but the amount of this endwise resistance in pounds, and its ultimate effects at great depths, had not been determined. It was supposed that by making use of a weight of thirty or forty pounds and a small fishing line, this resistance would be reduced to an inappreciable amount, or at least that its effect in retarding the descent of the lead would not be sufficient to destroy confidence in the results.

It appears, however, from the investigations referred to, that a weight, such as is ordinarily used in sounding, will be practically held in suspension at no very great depth, even when the line used is the smallest that will sustain the weight with safety in the air; and in confirmation of this conclusion, the fact is well established, that, notwithstanding repeated experiments made by the most skillful officers and with the utmost care, the bottom of the ocean has never been reached in its deepest parts; and even where the bottom has been attained and specimens brought to the surface, the uncertainties of the results have given good grounds for controversy with regard to the depth.

These failures and uncertainties do not arise from the magnitude of the distance to be measured, nor from the impenetrability of the fluid through which the lead has to pass: distances infinitely great and infinitely small in the universe above and around us, have been measured with precision; and the unexplored depths of the ocean are occupied by a medium freely and equally penetrable at all depths. Yet in this field, a field daily traversed by the commerce of the world, a distance of a few miles only has baffled all attempts to measure it.

The difficulty lies in the simple cause stated above, viz. the "endwise resistance" or friction upon the sounding line, which prevents the lead from going to the bottom where the depth is great.

The apparatus which I have devised, is designed to avoid this friction upon the line, while at the same time the line is not dispensed with, but is made use of, as in the ordinary mode.

Before describing this apparatus I will briefly refer to some of the results given in my previous report on this subject.

The rate of descent of an iron globe or sphere, as the simplest geometrical form, was first determined when falling freely in the ocean, and it was found that a sphere will attain a certain maximum velocity, within twenty-five feet of the surface, which velocity will be kept up without sensible increase or diminution to the bottom.

For a 32 lb. iron shot this uniform velocity is about sixteen feet per second.

The conditions of descent when a small line is attached to the sphere and drawn down with it, were then discussed, the line

being uncoiled from a reel on the deck of the vessel, and drawn down by the weight of the sphere. The friction of this line in the water causes a remarkable change in the rate of descent. Nearly the same maximum velocity at starting is attained, but the velocity becomes rapidly reduced, until the sphere becomes suspended nearly motionless in the water.

Taking the simple case of a 32 lb. shot attached to a small fishing line, the shot attains its maximum velocity of sixteen feet per second within twenty-five feet of the surface, but before a hundred fathoms of the line is drawn into the water, this velocity is reduced to eight feet per second—a diminution of half the velocity from the friction of one hundred fathoms of line. At five hundred fathoms the velocity is again reduced half, or to four feet per second; and at three thousand fathoms to about one foot per second. *Whereas at this depth, if there is no line attached, the shot will fall with its original velocity of sixteen feet per second undiminished.* Below this depth we may determine, in the same way, the circumstances in the two cases: the shot falling freely still retains its uniform velocity of sixteen feet per second at four, five, and six thousand fathoms depth, while with the line attached, at five thousand fathoms the velocity is reduced to a few inches per second, and at six thousand fathoms the descent is not perceptible under ordinary circumstances.

The time of descent becomes an important element also in practice; in the two cases given, the shot falling freely will descend to the depth of three thousand fathoms in twenty minutes, and to the depth of six thousand fathoms in forty minutes. While with the line attached, it will require two hours to descend three thousand fathoms, and eight hours to descend six thousand fathoms. These effects were shown to be due to the friction alone; the amount of which in pounds, was determined for different cases, in which different forms of weight and different sizes of lines were used; and the entire inapplicability of the ordinary mode of sounding for great depths, and even for ordinary depths, where the object is to obtain a correct knowledge of the depths, was demonstrated.

Methods have been proposed in which a line is dispensed with, by detaching a float at the bottom, when the plummet strikes, and watching for the return of the float to the surface; but this is impracticable, as there is no material applicable, within our knowledge, that will float to the surface from the bottom of the sea, on account of the great pressure, which condenses the bulk, so us to render bodies specifically lighter than water at the surface, heavier than water at even moderate depths.

A line must therefore be used to bring back to the surface any machine by which the depth may be registered in the descent.

And the motion of this line in an extended form in the water must be avoided.

The apparatus which I have devised is designed to secure this object,—by attaching to the sinker a tube or case in which the sounding line is compactly coiled, and from which it will be discharged freely, thus causing the plummet to carry down the *coil*, while one end of the line is held fast at the surface; the line being uncoiled from the descending sinker in the manner that a spider falling from a height gives out a thread in his descent by which he retains communication with the point above to which the thread is attached. The motion of the line in an extended form through the water being thus avoided, all the conditions of free descent are secured, and the plummet will descend to the greatest depths with a rapid and uniform velocity.

The depth is ascertained in the manner heretofore known as Massey's method, by a helix or curved blade, which is caused to revolve, by the motion of the apparatus through the water. Instead of Massey's indicator however, which from its faulty construction does not give accurate results, I have adapted Saxton's Current Metre, a much more delicate instrument, to this purpose.

A specimen tube is also used differing somewhat from those now in use, in construction but not in its essential points.

The lower end of the line is attached to the register and to the specimen-box which weigh together only two or three pounds, and as the line is hauled in from the bottom it brings up the register and specimen-box, leaving the plummet and attached case at the bottom.

The details of construction are shown in the accompanying drawings and description of the apparatus.

Besides overcoming the principal difficulty in sounding, there are other important advantages secured by this arrangement which simplify rather than complicate, the problem. These are as follows:

First, there is no strain upon the line, in the descent, except from its own weight, no matter to what depth or with what velocity, the plummet may descend.

It is possible therefore to employ a very small line; a single thread of silk may in fact be extended to the bottom of the ocean. This permits of the use of a line, which may be coiled compactly within a small space, the strength of the line being made just sufficient to insure its being hauled in with safety, bringing up at the same time the specimen-box and the register. The strain brought upon it, in hauling in, will depend upon the velocity, of the upward motion, which may be regulated accordingly.

Secondly, a *rapid* and *uniform* descent being secured, the indications of a revolving register will be reliable when attached to this plummet; while in the present mode of sounding the slow motion of descent at great depths, renders such a mode of registering the depth uncertain and unreliable.

Thirdly, there being no strain upon the line in the descent and the motion being *uniform*, it is practicable to determine the depth by the *time of descent*, making use of a small insulated wire as a sounding line, and determining the instant that the weight strikes the bottom by an electrical signal transmitted through the line. An apparatus was devised as long since as the year 1845, for ascertaining the moment when the weight strikes the bottom, by electricity, but in the mode of sounding heretofore employed, no particular advantage would result from this, while the danger of breaking the electric continuity is very great owing to the strain brought upon the line in the descent; and the plummet as now used descends with such a varying velocity, that even with the time of descent given, no calculation will give the depth. The method has therefore never been put in practice. Whereas, in the method proposed, there is no strain upon the line in its descent, and the plummet will fall through each successive hundred fathoms in the same time; *the time of descent will thus furnish a simple means of calculating the depth.*

In this process it will not be necessary to recover the line, and the time required to sound the ocean at any point, need only be that required for the plummet to sink to the bottom, moving with any velocity which may be desired.

I have made many experiments on the best method of coiling the line so as to secure its uncoiling with certainty, and without the possibility of strain upon the line, or the occurrence of a kink.

I have also given much attention to the quality and size of line to be used: upon these points, the practical working of the apparatus in a certain degree depends, but being merely mechanical questions they are easily settled. They are fully discussed in the description which accompanies the drawings.

The importance of the problem, which is thus sought to be solved, in connection with the survey of the coast, has never been questioned. A knowledge of the configuration of the bottom of the sea, adjacent to the coast, is necessary to the solution of many questions of importance to navigation, and to science, and especially that of the ruling feature of the Atlantic coast, the Gulf Stream; but besides these considerations the question has become one of great public interest in connection with the laying of submarine telegraphs; the risk of such enterprises being diminished in proportion to the accuracy with which the depth of the sea is known at every point of any proposed

line; and the ultimate practicability of such operations across the Atlantic being yet to be demonstrated by new and more accurate soundings.

DESCRIPTION.

The accompanying plate is a photographic copy of a drawing made from the first instrument constructed. Some slight modifications have since been made in the mode of attaching the register but without affecting the general design.

PLATE I.

Fig. 1. Represents the plummet as it appears in its descent.
T, the tube or case containing the coiled line.
W, the leaden or iron weight inserted in the bottom of the tube.
C, the conical cap.
R, the register in its place upon the cap.
L, the line.
Fig. 1 *a*. Represents a longitudinal section of the tube, weight and cap; showing the mode of coiling the line in balls, and the small specimen-box *s* passing through the hollow weight.
Fig. 2. Represents the register on a larger scale.
h h, the helices or blades.
r r, the register wheels.
g g, the locks for gearing and ungearing the wheels.
Fig. 2 *a*, represents the plan or horizontal view of the register, it being constructed so as to offer the least resistance in passing through the water.
Fig. 3, shows the detailed construction of the register wheels, and the helices.

From fig. 1, it will be seen that the form of the apparatus admits of rapid motion through the water. The weight is conical and elongated and the register presents the edges only, of brass plates to the water, and the line being uncoiled and discharged from the tube, there is no retarding force to the descent, from the line itself. Any desired velocity of desent may be given to the plummet by increasing or decreasing the weight W.

Fig. 1 *a*, shows the method of coiling the line.

There are various modes of doing this which are in common practice in twine and cotton factories; that which is here exhibited is the method of coiling in balls; all the balls exhibited in the tube being formed of one unbroken line, the line drawing out from the centre of each, until it is all drawn from the tube. The machinery for winding these balls is very simple; a drawing of that which I have used is herewith enclosed.

The essential points in the coiling are to coil the line in as compact a space as possible, and so as to ensure a certainty of discharge without danger of kinking. Two other modes of coiling are now under consideration, either of which may be better than the method by balls. One is to wind upon a spindle, and the other to lay the line in a sort of compound coil, directly in the tube. All these methods are now practised in the factories on a large scale, for winding twine and cotton.

The line used should be about five hundredths of an inch in diameter and as strong as it can be made of that size. A braided line of Holland

flax, or silk of five hundredths of an inch in diameter, may be made to bear a strain of 40 or 50 lbs.; which is abundantly strong for the purpose, as the weight and case are left at the bottom, the register and specimen tube only being brought up.

Tube.—The tube may be made of tin in sections of eighteen inches length, with stove-pipe joints and bayonet fastenings. The object of this is to adapt the length of the tube readily to the amount of line which it is to contain. A tube four inches in diameter will contain nearly a mile of line to each foot of the tube.

Sinker and Specimen-tube.—The sinker is made of cast iron or lead of any desired weight, depending upon the desired velocity of descent. A weight of 25 lbs. has been adopted. The sinker is conical and is inserted into the lower end of the tube containing the line and fastened to this tube by screws or by a bayonet joint and fastening. The weight has a conical hole or cavity through its entire length, through which the small specimen-tube passes in the manner shown in the drawing. The specimen-tube is a tube of thin brass passing through the weight and attached to the lower end of the line within the large tube. This specimen-tube is fitted with a valve opening upwards in the bottom, which closes when the tube is drawn up, thus retaining the mud which is forced into the tube when the weight strikes bottom. The specimen-tube fits loosely in the hollow of the weight, so that it may be easily drawn out as the line is hauled in.

Cap.—The cap is used for two purposes; to contract the upper end of the tube containing the line, so that the line cannot rise in bulk out of the tube, and for supporting the register. It is formed in the shape of the frustum of a cone, cut away on one side as well as open at the top, so as to allow the line to be discharged freely. A flat strap is fastened to the top of the frustum nearly in the line of the axis of the tube, and upon this strap the register is set as shown in the drawing; the register is kept in its place by loose collars.

Register.—The apparatus for measuring the depth consists of a helix or curved blade attached to a vertical axis, and wheels gearing into an endless screw upon this axis. The revolutions of the helix caused by the motion through the water are communicated to the wheels which are graduated so as to indicate the number of revolutions of the helix.

Two registers are attached to one plummet by attaching them together in the manner shown in fig. 2, by means of brass plates. The blades are made to turn in opposite directions and will operate as checks upon each other, and also counteract the effect of any rotary motion in the plummet.

The construction of the blades and wheels and the mode of gearing them with the endless screw are shown in fig. 3. The wheels are differential wheels, that is, they are concentric, one of them having one hundred teeth, and the other one hundred and one teeth. The cross-bar (*b*) has a slight motion carrying with it the wheels; this motion is governed by a spring *s*. To gear the wheels, the cross-bar is pressed towards the endless screw until the teeth gear with that screw and the bar is there locked, as shown in fig. 2, at *g g*. The revolution of the blade will now cause both wheels to turn, and after one hundred revolutions the wheels will be found separated by one tooth or one division. The differences thus measure hundreds of revolutions.

In the register from which the drawings were made, the blades revolve once in two feet; one hundred revolutions will therefore correspond to two hundred feet, or one division of the scale of the register to thirty-three fathoms.

When the register is hauled up, the arms at *g g*, fig. 2, drop, and the springs cause the wheels to ungear and fly back, where they are held motionless by a projecting point at *n*, fig. 3. The arms are made to drop by means of a small wire which is attached to the cap as shown at *u* fig. 1; this wire is fastened to, or hooks over the ends of the arms, and when the register is drawn off, the arms fall.

Mode of attaching the line to the register and specimen-tube.—Before the line is put into the tube it is attached to the specimen-tube at a point four or five feet from the end of the line, the spare end is passed through the tube, and when the balls are all put in the tube the extreme end of the line coming out at top is attached to the register, after taking a few turns round the top of the strap, the register being in its place.

The line is thus attached to the register and specimen-tube only, and not to the large tube or weight. When the plummet strikes the bottom a part of the line will remain in the tube coiled; by hauling in the line this part will however be uncoiled, and on coming to the bottom of the coil, the specimen-tube will be drawn up through the large tube, and after the specimen-tube comes out the register will be drawn off the strap, and thus the large tube and weight will be disengaged from the line, specimen-tube, and register; and by continuing to haul in, the register and specimen-tube will be brought to the surface.

The plummet on striking will, under most circumstances, remain sticking in the mud in an upright position.

ART. II.—*Notice of New Localities, and interesting varieties of Minerals, in the Lake Superior region: supplementary to the chapter on this subject, in Part* II. *of the Report of Foster and Whitney;* by J. D. WHITNEY.

SINCE the publication of the second part of our "Report on the Geology of the Lake Superior Land District," in 1851, some materials, illustrative of the mineralogy of this region, have accumulated in my note-books, which, in the present communication, I have put together in the alphabetical order of the minerals noticed, for convenient reference. A few of the facts here stated were communicated to J. D. Dana, for the last edition of his "System of Mineralogy," and are here repeated, with some additional remarks on the general mode of occurrence or economical importance of the ores and minerals mentioned.

Analcime.—This mineral is quite abundant on Keweenaw Point, and has also been noticed by me on Michipicoten Island; it does not appear to have been observed in the Ontonagon region. The finest locality, however, by far, is at the Copper Falls

and Northwestern mines; and, especially, at the last-named place, where work is, for the present, suspended. Both these mines are, in fact, on the same vein, the Copper Falls mine being to the north, and the Northwestern to the south of the great belt of crystalline, unproductive trap, which runs through the middle of Keweenaw Point. In this vein, analcime occurs in large and almost transparent crystals forming geodes in the greenish magnesian silicate which is the principal gangue of the vein. These crystals are all trapezohedrons, and sometimes occur an inch in diameter; they occasionally have a thin incrustation of chrysocolla. The analcime, at this locality, is almost always associated with the peculiar form of orthoclase, so common in the copper region, and which will be noticed farther on.

At the Old Copper Falls vein analcime has been found in radiated-fibrous as well as granular-massive forms, and of a bright red color.

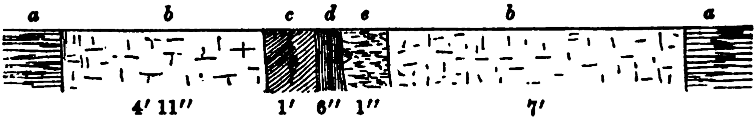
Apophyllite.—The foliated variety, or ichthyophthalmite, was found in great abundance in 1853 in the rubbish thrown out at the workings on the Prince vein, on the north shore. A variety in small, brilliant, deep-red crystalline scales or spangles, disseminated through calcite, forms curious and elegant specimens. The most usual occurrence of apophyllite at this locality is in large contorted plates, somewhat resembling the variety of calcite known as argentine. Crystalline specimens are occasionally met with at the Cliff mine, but none have been noticed in the Ontonagon district.

Barytes.—There are numerous veins of sulphate of baryta on the north shore of the Lake, and especially along that portion lying to the northwest of Isle Royale, as also on that island, and the smaller ones which lie near the main land to the westward of Thunder Bay. These veins vary in width from a few inches to several feet, and are usually made up of quite compact barytes without crystallization, and destitute of accompanying metalliferous ores.

The famous "Prince vein," on Spar Island, is one of the most conspicuous and interesting objects, at least in the eye of the mineralogist, in this region. As it makes its appearance on the south side of the island, on the precipitous face of the trap cliffs, which rise nearly vertically from the water, it may be seen from a distance of several miles out on the lake; and when shone upon by the sun, resembles a magnificent waterfall, its brilliant white contrasting strongly with the dark color of the trappean rocks in which it is enclosed.

The course of this vein is about N. 32° W., or nearly at right angles to the general trend of the coast of this portion of the lake. At the southern edge of Spar Island it is fourteen feet

and seven inches wide. Here the vein is made up of bands of calcite, crystalline quartz and barytes, as represented by the annexed cross-section.



a, a, trap; *b, b,* coarsely crystallized calcite; *c,* barytes; *d,* calcite with copper pyrites; *e,* quartz and calcite.

At the point where this section was taken the ore is confined to a band of calcite in the centre of the vein and about six inches in width. The metalliferous portion of the lode consists here of chalcopyrite and erubescite,—in small quantity, however, as compared with the amount of barren veinstone connected with these ores.

On the main land, about two miles distant, the vein reappears a little way back from the shore, where it is much split up; but when followed a few rods farther to the northwest it concentrates again, and appears to have a width somewhat greater than on Spar Island. A drift has been carried in on the vein for a distance of 165 feet, from which most magnificent crystallizations of amethystine quartz and calcite were obtained. An examination of the back of the drift shows that if workings should be resumed here, a rich harvest, for the mineralogist at least, would be gathered, the veinstone being highly crystalline in its texture. The metalliferous contents, however, seem to be chiefly limited to blende. At the point in the level where a winze has been sunk to the depth of 90 feet, and near the collar of the winze, a considerable quantity of native silver was obtained in fine laminæ between the joints of the blende. A large sum of money was expended here, after the discovery of the rich bunch of silver, but it does not appear that a second one was ever struck. A single minute point of native silver rewarded our patient search of hours among the veinstone for proof of the existence of the precious metal.

In no other vein in this neighborhood were any interesting crystalline minerals observed, although the exposures on the lake shore are usually good.

Chalybite.—This mineral has been observed by Dr. G. H. Blaker in the talcose slates near Marquette; it forms narrow strings and bunches in the veins of milky quartz which ramify through the slates. The quantity is not sufficient to make it of any economical importance.

The same mineral occurs, associated with chalcopyrite, in the quartz veins at Echo Lake, near Saut St. Marie. The geological position of these veins is the same as that of the Marquette slates.

Chrysocolla.—Handsome specimens are found in the Copper Falls vein, forming delicate stalactitic incrustations on the veinstone, and sometimes coating the crystals of analcime.

Chalcopyrite.—Veins of quartz containing this ore are numerous in the trappean rocks of the Azoic series, in the neighborhood of Echo Lake, about 15 miles east of Saut St. Marie. Copper pyrites is the predominating ore at the Bruce and Wellington mines on Lake Huron: it has also been found in veins in the Huron Mts., on the south shore of Lake Superior, where no mining has yet been carried on.

Copper.—The native metal is now the exclusive object of mining enterprise on Lake Superior, no veins producing *ores* being now worked, on either the north or the south shore. The sulphurets, however, are still mined on Lake Huron, in the Azoic rocks, a formation which has not been proved as yet on either shore of Lake Superior, to contain any workable vein of the native metal.

The largest mass of copper yet discovered on Lake Superior was in the 10-fathom level of the Minnesota mine, on the so-called "conglomerate lode," or the copper-bearing vein which lies between the trap and a thin bed of conglomerate that runs through the mining ground, and which has been opened to a depth of between 80 and 90 fathoms without ceasing to produce largely. This mass was 46 feet long, and is said by the superintendent of the mine to have weighed about 400 tons: a single cut across it exhibited a thickness of six feet of pure metallic copper. This mass was estimated to contain at least 90 per cent of the pure metal. The operation of cutting it up lasted thirty months.*

Almost all the specimens collected on Lake Superior as *crystallized copper*, are, in reality, not actual crystals, but only imitative forms produced by juxtaposition with the crystalline faces of some mineral substance, and usually of calcareous spar. The large masses which are seen in collections, and labelled "crystallized copper from the Cliff mine," usually exhibit only a few indistinct planes which can be referred to the crystalline force of the metal itself.

The finest groups of crystals ever obtained in the copper region were from the Old Copper Falls mine, a locality which has long ceased to be worked; and no other has furnished any specimens to compare with those found here.

The predominating form in these groups was the rhombic dodecahedron; but the octahedron was not of unfrequent occur-

* The size of the pieces into which the great masses are cut for convenient handling under ground and shipment is now much greater than it was formerly: blocks of copper weighing from 8000 to 9000 pounds are not unfrequently brought to the surface and sent off to the smelting works.

rence. The diameter of the perfectly formed crystals rarely exceeded one-fourth of an inch, although single crystals from this locality, octahedrons, have been seen as large as an inch across their bases. The finest single crystals, as far as ascertained, are from the Cliff mine, and are tetrahexahedrons. One in my collection, considered by many the most beautiful crystal ever found in the Lake Superior region, is about three-fourths of an inch in diameter, and nearly perfect.

The occurrence of native copper as a pseudomorph after aragonite, reported by Söchling* as from Lake Superior, may with the strongest probability be set down as an error. It is very likely that the pseudomorph in question was from Corocoro, South America, where interesting ones of this kind do occur. There is a very great tendency to confusion in the localities of American minerals sent to Europe, as every mineralogist on this side of the water has learned by experience. No aragonite has ever been found in the copper region, as far as I know. Native copper, as a pseudomorph of calcite, has been noticed by me in a single instance, in a specimen from the Old Copper Falls vein.

The specific gravity of the native copper, sawn from the interior of a large mass of the chemically pure metal, has been previously stated in our Report at 8·838; this is lower than that given by Erdmann and Scheerer† as the specific gravity of crystallized copper. The specific gravity of the copper smelted at the furnace near Detroit was found to be considerably less than that of the native metal. A piece sawn from the centre of an ingot, and showing no signs of any air-bubbles, gave a specific gravity of 8·601; another portion of the same ingot taken from near the surface gave 8·570; both pieces appeared, under the magnifying glass, equally free from bubbles.

This copper, which was smelted from masses brought from the Toltec mine, was found on examination to be chemically pure, with this exception, that it contained $\frac{3}{10000}$ of silver, about seven ounces to the 2000 lbs.

Datholite.—Fine crystals of this mineral have been found only at the locality on Isle Royale, which has long since ceased to be worked, the island being now entirely deserted by all except a few fishermen. There are several localities on Keweenaw Point, however, where it occurs in great abundance, but not, so far as I have observed, in handsome crystallizations. The gangue of the Hill vein, on the Copper Falls location, consisted, in a portion of its more northern extension, of a greenish magnesian silicate penetrated, in every direction and sometimes forming a sort of breccia, with branches and strings of datholite. It is usually massive, translucent, highly vitreous in lustre, and of a light

* Pogg. Ann., civ, 332.

† Erdmann and Marchand's Journal, xxvii, 194.

flesh-red color, owing to the presence of a minute quantity of suboxyd of copper diffused through it.

The veinstone of the Ontonagon region had seemed to be quite destitute of this mineral, and it was not until last summer that it was discovered by me in that district. At the Minnesota mine, among the vein-stuff thrown out, some singular nodules were observed looking like rusty cannon balls. On breaking one of these open and examining it, it was found to be datholite, in a singular and hitherto unobserved form.

The mineral is quite compact, breaking with a conchoidal fracture, perfectly white, opaque, and resembling in its physical character the purest and most close-grained marble. Its hardness = 4·5; specific gravity 2·983.

An analysis of this mineral by Prof. C. F. Chandler, gave the following results:

Silica,	37·41
Oxyd of iron and alumina,	·35
Lime,	35·11
Boracic acid (by loss),	21·40
Water,	5·73
	100·00

The quantity of datholite which is found on Lake Superior is very considerable, but it does not occur as a constant ingredient of the veinstone in any of the large mines now worked; and it is not probable that it will become of economical value for the extraction of the boracic acid it contains, however interesting it may be in a theoretical point of view, as connected with the origin of the cupriferous veins.

Hematite.—The purity of the mountain masses of iron ore, which are now extensively mined at various points from 14 to 17 miles west of Marquette, may be inferred from the following analyses recently made of specimens from the three principal mines, or quarries, as they may more properly be called. The specimens are, indeed, selected ones; but an inexhaustible supply of ore of the same quality could be obtained, without rejecting any considerable amount of the stuff which is quarried out, were it desirable to ship a perfectly pure ore. The average yield of the ore shipped would, in point of fact, fall but little below that given by the following analyses.

	I.			II.		III.	
	a.	*b.*	*c.*	*a.*	*b.*	*a.*	*b.*
Insoluble,	1·02	·80	·54	7·92	7·96	1·99	2·05
Iron,	69·41	70·22	69·96	64·42	64·01	68 81	
Oxygen and traces of lime, &c.,	29·57	28·98	29·50	27·66	28·03	29·20	

I. is ore from the Jackson, II. from the Cleveland, and III. from the Burt or Lake Superior mountain. The fragments analyzed were, in each case, broken from the different portions of

the same large specimen, one object being to ascertain what the variations in the quantity of oxygen were, in different portions of the same mass. I. *c.* is the mean of three closely-agreeing determinations.

In the above analyses, the iron having been precipitated from the chlorohydric acid solution by ammonia, the filtrate was evaporated to dryness and ignited, and in no case did the residuum amount to more than a few hundredths of one per cent. In I. *c.* and III. *b.* there was a weighable quantity of lime present, amounting, in each case, to 0·05 per cent. It was not possible, in any instance, to obtain a weighable amount of alumina. The oxygen was therefore determined by the loss, as giving more accurate results than could be obtained by the process of reduction with hydrogen. It appears, therefore, that these ores are mixtures of the peroxyd with a minute and varying portion of the magnetic oxyd.

Both the Burt and Cleveland Mountain ores show minute crystals of magnetite scattered through their mass; in the Burt ore these crystals are from $\frac{1}{16}$ to $\frac{1}{12}$ of an inch in diameter; in the Cleveland, so small as to be hardly visible without a magnifying glass. No sulphur or arsenic could be detected in any of the specimens examined. The insoluble portion consists of silica, with only traces of lime, alumina and magnesia: this silica is partly in combination with the iron in the form of a silicate of iron, and partly present in the form of grains of quartz. On the whole, it may be said with truth that these ores surpass in purity any known to exist elsewhere in the world in anything like the same quantity.

Leonhardite.—This mineral has been observed only in the Old Copper Falls vein, where it was very abundant; but a careful investigation would probably reveal its presence at other localities. An examination was made of this mineral to ascertain at what temperature it parts with a part or all of its water, with reference to H. Rose's investigations on Laumontite, which he has shown to lose a portion of this constituent at 100° C. The results gave on the mineral in small fragments:

Dried at	Loss of weight.
80°	1·46 per cent.
90°	0 "
100°	0 "
Ignition,	11·89 "

The 1·46 per cent is probably not essential to the constitution of the mineral; the loss by ignition agrees well with the formula which takes the oxygen ratio of the bases and silica as 4 : 9, and 12 $\dot{H}$.

Limonite.—This ore of iron has recently been discovered and for the first time on Lake Superior in any noticeable quantity.

It occurs at the Jackson iron mountain, where it forms beds of several feet in thickness, occupying depressions in the anhydrous ore, from the decomposition of which it may have been formed. The analysis gave the following results:

Silica,	6·54
Iron,	60·08
Water,	9·31
Oxygen and traces of lime and magnesia,	24·12
	100·00

No sulphur or manganese could be detected; the original ore appears to have been only partially converted into limonite, as the quantity of water given by the analysis is considerably less than that required to form a hydrous peroxyd of iron. It is used at the Pioneer Furnace, near the Jackson Mountain, and considered to aid in the reduction of the ore.

Manganite.—Handsome specimens of this mineral were given me by Dr. G. H. Blaker, of Marquette, as having been procured in that vicinity; the exact locality is not known to me.

Nickel and Copper, arseniuret of.—This is the same mineral noticed by T. S. Hunt (this Journal, [2], xix, 417), and afterwards more fully described in the Report of the Canada Geological Survey, 1853–6, p. 388. The result of my analyses, made two years ago, confirm entirely those already published by Mr. Hunt; the mineral, which appears homogeneous in composition, being in fact a mixture of the arseniurets of copper and nickel.

Two analyses of different specimens broken from the same mass gave as follows:

	I.	II.
Arsenic (by loss),		47·01
Copper,	14·56	20·94
Nickel,	33·35	31·24
Silver,		·24
Gangue,		·57
		100·00

Specific gravity 7·527.

In II. the quantity of arsenic required to form with the copper domeykite, and with the nickel copper-nickel, is 47·86 per cent, which agrees pretty nearly with that given by the analysis.

The specimens obtained by me on Michipicoten island in 1853, are in coarsely crystallized calcite, and form nodules having a structure in concentric layers. The portions selected for analysis appeared perfectly homogeneous and had almost exactly the color and general appearance of copper-nickel. This ore was obtained in mining for silver on the island, from the trappean rocks; but on examining the excavations it did not appear that there was any regular vein of this or any other metalliferous mineral, the ore occurring in irregular nodules disseminated through the trap. There is little reason to believe that either

nickel or silver occur at this interesting locality in sufficient quantity ever to become the object of a profitable mining enterprise. The beds of rock appear to be too thin, and their changes of lithological character too sudden, to admit of the development of well characterized veins.

Orthoclase.—In almost every collection of Lake Superior specimens may be seen bunches and geodes of minute reddish crystals, accompanied by native copper, calcite and the zeolites, the usual vein-minerals of that region; these crystals are usually labelled "stilbite," but they are, in reality, orthoclase, as is evident from their physical characters and chemical composition.

The mineral here referred to, which has, on casual inspection, but little resemblance to feldspar, is the same one noticed on page 102 of our Report, where an imperfect analysis of it is given. The peculiar interest attaching to this anomalous occurrence of the substance in question seemed a sufficient reason for completing its analysis, and adding some further remarks on its associations.

This mineral occurs in minute crystals which are rarely as much as one-tenth of an inch in length; they are rhombic prisms, but not very distinct, or brilliant enough to be measured by the reflecting goniometer. The angle of the prism is about 118°, or near that of *I* on *I*, in common feldspar. The terminations of these prisms are usually rough and indistinct, but formed by a single plane, probably 1*i*; more frequently the crystals are aggregated together into a confused crystalline mass, the individuals being too minute and ill-defined to be made out without a magnifying glass. The mineral agrees in its physical characters with orthoclase, fusing before the blowpipe with some difficulty to a blebby glass.

The analysis gave:

Silica,	65·45
Alumina,	18·26
Oxyd of iron,	·57
Oxyd of manganese,	*trace*
Potash,	15·21
Soda,	·65
	100·14

The above results indicate, beyond the possibility of a doubt, that the mineral is really orthoclase.

The occurrence of feldspar as an associate of, and in intimate connection with, the zeolitic minerals, which form so large a portion of the gangue of the cupriferous veins, and, indeed, its presence at all in a vein-stone, is a matter of too much importance not to be dwelt upon. Instances of this kind are, as yet, sufficiently rare, and there are some points connected with the occurrence of the feldspathic element in the Lake Superior veins which add to the interest with which these specimens are invested.

Orthoclase has been recognized and described as occurring in the mineral viens of Schemnitz and Kongsberg,* although the possibility of such an association has, until within a few years, been hardly allowed. The well-established fact of the existence of feldspar as a pseudomorph, of the form of laumontite and of analcime, in the trap of the Kilpatrick Hills, near Dumbarton, Scotland, furnishes incontestible evidence of the possibility of the formation of this mineral in the moist way, and the phenomena exhibited on Lake Superior in connection with the association of feldspathic and zeolitic minerals, point as clearly to this conclusion as they do to the necessity of rejecting the igneous theory of the origin of the veins themselves.

The variety of orthoclase of which the analysis has been given above is found in almost all the mines, from the extremity of Keweenaw Point to the Ontonagon; but in the latter district it is most abundant. At the Northwestern mine, the association of orthoclase and analcime is almost constant, and there are few geodes which do not exhibit delicate crystallizations of the first-named mineral so situated with reference to the other as to lead to the conclusion that their formation must have been going on at the same time and under the same circumstances. The crystals of orthoclase are also, at this locality, frequently scattered, singly, over delicate incrustations of a very soft magnesian mineral, which hardens somewhat on exposure to the air, and which is probably saponite, but of which I have never been able to procure enough for an analysis. This mineral seems to have been the last formed of all the vein-minerals of this region.

At the Old Copper Falls vein, orthoclase, of a bright red color, occurs lining the interior of cavities in the gangue, and forming with associated calcite and crystallized copper, specimens of great beauty. The calcite, not unfrequently, has crystallized over the orthoclase in such a manner as to be colored deep-red by it. The same may be said in reference to the joint occurrence of natrolite and orthoclase at this locality. There is clear evidence here of the contemporaneous formation of the copper, natrolite, calcite and orthoclase.

In the Ontonagon region, the minerals associated with orthoclase are chiefly quartz, epidote and calcite. At the Aztec and Ridge mines, geodes lined with delicate crystallizations of these are not unfrequent. Minute crystals of scolecite or natrolite have been noticed in the same connection. At the Minnesota mine, the large crystals of quartz, formerly obtained there in abundance, were frequently encrusted with a thin layer of crystals of orthoclase.

It may be remarked, that the crystals of this mineral are, throughout the whole copper region, remarkably uniform in

* See Leonhard and Bronn's Jahrbuch, 1850, p. 43; also Bischof's Geology, ii, 330.

their size, color, and general habit. They are rarely more than a few hundredths of an inch in length, have the same crystalline form, and are, with rare exceptions, of a light reddish color.

Feldspar, in no instance, so far as has yet been observed, forms the bulk of the veinstone; it is only met with in comparatively minute quantity, although occurring in numerous localities. Only a single instance has been noticed where a crystal had a length as great as one-tenth of an inch, and this was an imperfectly formed one.

Note.—Weissigite, described by Jenzsch, is undoubtedly orthoclase, as suggested in Dana's Mineralogy, p. 513; this was found in a porphyritic amygdaloid, with chalcedony and quartz, and is spoken of by Jenzsch as the first known instance of the occurrence of a feldspathic mineral in an amygdaloidal cavity of a rock of this class.

Serpentine.—Well-characterized serpentine has not yet been found in the Lake Superior region; but a substance closely related to this mineral, and, in fact, differing from it chiefly by the substitution of protoxyd of iron, in a large but varying amount, for a portion of the magnesia, forms the head-land of Presqu' isle, near Marquette. An imperfect analysis of this rock was given in Foster and Whitney's Report, Part II, page 92. Since the publication of that analysis new specimens have been collected, and a more thorough examination made of it, of which the results here follow.

The substance is of a deep green color, so deep as to appear almost black; its powder is light greenish-gray. Its hardness is a little above that of common serpentine. It is readily attracted by the magnet, when broken into small fragments. In some specimens minute octahedral crystals of magnetic iron ore disseminated through the mass can be seen with the aid of the magnifying glass. The substance is readily attacked by chlorohydric acid, even in the cold, if finely pulverized; but a small portion of unattacked mineral remains behind when the insoluble residuum is treated with carbonate of soda in the usual way. It amounts to from two to six per cent, and appears to be an insoluble silicate mechanically mixed with the serpentine; it is probably hornblende, but has not been analyzed.

The analyses of three specimens collected at some distance from each other, gave the following results, as the composition of the soluble portion of the substance:

	I.	II.	III.
Silica,	36·95	37·25	
Magnesia,	33·07	28·67	14·33
Soda,	·97	1·16	
Protoxyd of iron,	16·50*	14·14	19·52
Peroxyd of iron,		6·75	12·90
Water,	10·40	10·89	
		98·86	

* Estimated as protoxyd.

In analysis II, in which all the ingredients are determined, as well as the relative amount of the oxyds of iron, the calculation gives, for the ratio of the oxygen of water, protoxyd bases and the silica, leaving out of consideration the peroxyd of iron as being a mechanical intermixture, the numbers 1 : 1·49 : 1·99; or, almost exactly, 1 : 1½ : 2, which is the ratio given by the analyses of serpentine.

Silver.—Native silver still continues to be found in considerable quantity, in connection with the copper, at the principal mines on Lake Superior, especially at the Minnesota and the Cliff. The amount obtained at the Minnesota in 1857, by the company, was $655.44: this, however, was but a small portion of what was really found, as the miners are well known to appropriate almost all the silver they discover. The metal has never been noticed by me in distinct crystals, except in one instance, namely, at the Copper Falls mine, where a few well formed cubes about one-tenth of an inch in diameter were obtained.

Most of the fine specimens of silver from the Lake have been associated with calcite, which is dissolved away by an acid, leaving the metallic mass exhibiting the impressions of the planes of this mineral, as is the case with the copper specimens, as before remarked.

Zeolites.—To close this article, a few remarks may be added on the occurrence of the zeolitic minerals in the Lake Superior region, and especially as vein-stones.

By far the most abundant zeolites of the copper-bearing veins are prehnite and laumontite, or the closely allied species, leonhardite. The cases are rare, however, in which either of these minerals constitutes the bulk of the gangue of a vein, except in the case of narrow strings and bunches of limited extent. Quartz and calcite are the predominating vein-minerals, the zeolites being decidedly subordinate to these, especially in the great, productive lodes. The zeolites, moreover, are chiefly confined to transverse veins, or those crossing the formations at a high angle: in the Ontonagon region, where the great lodes have the same strike as the beds of rock, zeolitic minerals are of comparatively rare occurrence in the vein-stone. In this class of veins quartz and silicious material greatly predominates over all the other minerals, and there is much more rock intermixed with the vein-stone proper. Datholite may be noticed in a few instances among the transverse veins, as forming the larger portion of the gangue near the surface; but in no such case has mining been carried to any considerable depth, so as to ascertain how far this state of things continued.

On the whole, the diminution of the zeolitic portion of the vein-stone is marked as the mines are extended downwards: the only crystalline mineral observed in a recent careful examination

of the Minnesota mine, at a depth of from 70 to 80 fathoms, was calcite. Traces of what appeared to be laumontite were noticed along the selvages of the lode, which at this depth is quite as rich in copper as anywhere above, but the lode seemed to be very compact in its texture and no other zeolite was seen in it.

The entire, or almost entire, absence of some of the more common zeolites from the Lake Superior region is worthy of notice. Those minerals which are most characteristic of the Nova Scotia trappean rocks are almost entirely wanting on the Lake. Neither chabazite, stilbite or heulandite have ever been observed by me in the copper region, on the south shore of the Lake.* The analogy of lithological character between the traps of Nova Scotia and those of Lake Superior, which has frequently been urged as a reason for considering them of the same geological age, and which has not yet been made evident by an analysis of the rocks themselves, fails entirely when considered with reference to the associated minerals.

Of the zeolites occurring on Lake Superior, pectolite, leonhardite and chlorastrolite appear, thus far, to be limited to a single circumscribed locality, while harmotome is reported in only a doubtful crystal. The only new zeolitic mineral noticed is chlorastrolite, which is quite common along the beach of Isle Royale, for a distance of two or three miles, but which has not been discovered at any other point on the Lake.

The occurrence of the zeolites on Lake Superior is not absolutely, although chiefly, confined to veins. All the fine specimens of crystallized minerals of this class have been obtained from the cupriferous veins, so that this may be considered as the normal mode of occurrence in this region. Where the trappean rocks assume an amygdaloidal structure, we have, occasionally, prehnite, chlorastrolite, etc., in radiating fibrous masses, filling the cavities; but quartz in the form of agate and chalcedony and calcite are much more common. There are occasional flat tabular masses of laumontite mixed with prehnite found lying in the direction of the lines of bedding of the trap, but these are thin and of limited extent. Many of the trap amygdules are filled with a mineral resembling chlorophæite and others with saponite. Most of the substances thus occurring are only to be recognized by chemical analysis, as they are generally finely fibrous or massive.

* These minerals are reported by Messrs. Owen and Norwood as occurring on the Minnesota shore of the Lake, west of Pigeon River, a region to which my explorations have not extended. I have, however, examined numerous specimens from that part of the Lake, without having discovered either of these zeolites.

ART. III.—*On some questions concerning the Coal Formations of North America;* by L. LESQUEREUX.

IT may perhaps be said that as everybody is now acquainted with the coal, with its essential constituents and the general laws of its formation, an attempt to offer to science something new or even interesting on the subject, must prove a fruitless task. This assertion has a semblance of truth only, for it is certain that some of the various and most important phenomena connected with the formation of coal are not satisfactorily, nor even at all explained. And as they are continually brought forward for discussion, either by lecturers or systematic geologists, the subject of the formation of coal, considered as a whole, has been obscured in such a manner that it is doubtful if the most essential facts on the subject, some of which may be considered as demonstrable, are not still looked upon by many as hypothetical and individual opinions. It is with these peculiar phenomena of the coal formations, and consequently with the exposition and the discussion of geological facts connected with them, that we have to deal in the first part of this paper.

As we cannot expect to come to a right understanding of the formation of coal without some acquaintance with the vegetation of whose remains it is made, our attention must necessarily to some extent be directed to the flora of the coal period. But it is not enough to know the peculiar nature, the anatomical and chemical constitution, of the coal plants. It is necessary to study them also in their geographical distribution, in the different coal basins of America and of other countries, and also in the successive strata of the coal at different geological horizons. And it would be desirable also to examine the vegetation of the coal in connection with other external influences, in order to become acquainted if possible with the climatic conditions that prevailed at the time of the coal formation.

The plan that we propose to follow may accidentally direct the discussion to some points which do not appear to have a close relation to the formation of the coal. But we must bear in mind that geological eras are not very distinctly limited; or at least that to have a true understanding of one of them it is necessary sometimes to examine the causes that have prepared it, or that may have brought it to a close.

The supposition that coal is a true mineral, formed in certain strata of our globe only by some chemical agency and without an accumulation of wood grown on the surface and buried afterwards, has been recently revived among us, though it had long since been put aside, and apparently forever, as contradicted by all the appearances of the coal deposits and by the nature of the

coal itself. It would be useless, again to show the groundlessness of an hypothesis to which nature does not give the slightest apparent support.

The supposition that the matter of the coal (the wood) was heaped in some hollows or basins by the agency of water, as by currents of the sea or of some river, or by some other external cause, hurricanes, partial or general floods, sinking of the ground covered with thick forests, &c., has been also generally abandoned as contradicted by general evidence. The reasons against it may be briefly enumerated. They are found: 1. In the stratification of the coal measures; and also of the coal itself, which upon close examination appears to have been formed by successive layers of matter. 2. In the presence of plants in the coal and in the shales above it, plants preserved in the integrity of their most minute and fragile parts, and in a position which shows that they have been buried at the place where they have fallen from the trees or the bushes and where they grew. 3. In the absence in the coal of any matter foreign to it, of sand, of mud, &c., the ashes of the coal being generally in exactly the same proportion as in the wood. 4. In the thickness of some beds of coal containing a quantity of matter far greater than could be furnished by a buried forest.

The theory of the formation of the coal by the heaping of consecutive layers of plants and trees grown in place, preserved in water and buried afterwards; or the peat-bog theory as it is called by some, is then the only one admitted now as satisfactorily explaining the process of formation of the coal. The analogy of formation between the peat-bogs of our time and the beds of coal of the old measures cannot be called a theory; it is a demonstrable fact. We can now see the coal growing up by the heaping of woody matter in the bogs. After a while we see it transformed into a dark combustible compound that we name peat or lignite according to its age. We then see it hardening either by compression, or by this slow burning in water that has been so well explained by the experiments of Liebig. Most of the peat bogs of Europe, at least the oldest, have at or near their bottom some plates or thin layers of hard, black matter, that ocular examination or chemical analysis fail to distinguish from true coal. We find besides in Holland, Denmark and Sweden, thick deposits of peat separated into distinct beds by strata of mud and sand, giving the best possible elucidation of the process of stratification of the coal measures.

It is not only in their general features that both formations are so much alike. But in the minutest accidents and even local peculiarities, their agreement is clear and unquestionable to one who has studied the formations of the peat bogs of our time. We quote a few examples.

An author, speaking lately of the formation of the coal, mentions the presence in the coal of *wedge-shaped masses of vascular tissues found imbedded in the midst of the more structureless bituminous matter of the coal.* He accounts for this fact by supposing that these tissues are the remains of floated logs, which have finally become imbedded in the carbonaceous matter below. This supposition is rather an extraordinary one. If the coal has been formed like the peat bogs, there can not be any *floated* logs in the compound. If there were floated logs in the coal, this would take us back to the formation of the coal by transportation. In every peat bog, the process of burying trees is in constant operation. The preservation of the logs which cannot be covered with water when they fall on the ground, is due to the agency of a moss, the *sphagnum* which extends its compact tufts always saturated with water like a sponge, over every fragment of wood, from the smallest to the largest. The *Sphagna* work like the ants to bury their treasures; and as their growth is continuous and stopped only by the frost, the heaping of their own woody matter which forms the *structureless* peat added to the wood which they have to preserve and the other plants of the marshes gives an appreciable thickness for each year. In the peat bogs of Switzerland, peat grows at the rate of two inches per year, a thickness reduced to one half by compression. In the same peat bogs, the *Sphagna* do not require more than three years to cover the stem of a tree of moderate thickness.

The bogs then, even the largest, enter naturally and without transportation into the composition of the coal as they become part of the matter of the peat bogs. In the deep bogs of New Jersey, there is a class of woodmen whom I would call log-fishers, who sound the marshes with long poles, to find the sound logs which they dig out of the black and already combustible mould or peat, from a depth of from six to ten feet. Some old swamps of Northern Europe contain as many as four or five generations of trees of different kinds imbedded from twenty to fifty feet deep and separated by thick beds of compact, entirely decomposed woody matter or peat. Some of those bogs are so abundantly filled with sound and large logs of oaks, pines and birches, that their removal has gone on for more than half a century before there was any material diminution of the supply, and for a long time it was supposed and even maintained that the trees of those marshes were growing under ground.

The flattening of all the stems found in the coal and in its shales, and also the layers of bark observed in the same formations, without any trace of internal woody structure, have also attracted a great deal of attention and useless theoretical discussion. In the oldest peat bogs of Germany, especially in the large swamps or lignite-deposits of the Pliocene of Saxony, the

trees are found all softened and already flattened to a greater or less extent. Some of the buried forests of England show the same appearance. From some clay banks exposed by a slide in the Jura mountains, large trees of recent species, still living in the country around, have been exhumed, and though the wood still preserves its natural appearance and its tissues, it has lost its hardness of texture and has become as soft as the clay itself. Hence, as Liebig has proved by direct experiments, in the process of slow decomposition or rather slow combustion in water, the woody matter is generally softened before its hardening and entire transformation in coal.

In Denmark, there are immense meadows, extending for miles along the shores and covering old deposits of peat or combustible matter to a depth of from six to eight feet. The entire mass consists of a half fluid paste with layers of the bark of alder and white birch, rolled, flattened or pressed like the leaves of a book. Farther back in the interior of the country, especially in the royal park of Copenhagen, the formation of this kind of peat can be followed in all its details. First a thicket of alders and birches sprout out, covering an overflowed surface of ground. The thicket is impenetrable, and soon presents a confusedness of stems and interlaced branches. Then, as the trees become older, the whole mass begins to decay, especially at the level of the water, and by and by it falls down by its own weight, becomes submerged in a few years, and from its own seeds upon the mould of its half floating, half decomposed remains, a new generation of trees appears again and the process of formation is continued in the same way. The internal woody matter of the trees, the lignine, is decomposed at first and reduced to a paste, while the bark, impregnated with resins, is preserved for an indefinite period. In the coal basin of Trevorton, Pa., there is a perpendicular wall presenting to the eye a beautiful picture of prints of Lepidodendra and Sigillariæ, crossing each other in every possible direction, all thin layers of bark superposed without any woody or carbonized matter between. It is nothing but the surface of an old coal-swamp, formed like the peat bogs described above. The peat which it covered has formed the coal, and the woody matter floating in water above it has been mixed with mud and formed the shales.

If it is true, as we said before, that all the peculiar accidents of the coal formations can be thus exemplified and explained by phenomena now observable in the growth of the peat, is it not surprising that the peat-bog theory of the formation of the coal should be still exposed to so many contradictions, and especially be subjected to continual and hypothetical modifications, which, destroying its simplicity, render it then truly unsustainable. The following reasons have been repeated time and again. The

repeated succession of various strata in the coal measures, viz., the constant alternation of fire clay containing roots of trees, with coal and shales, both containing remains of land plants or of marine shells; with limestone containing madrepores and shells of the deeper seas; with sandstone mostly without any fossil remains: this alternation evidently shows that at the time when the formation was progressing, the sea was continually brought in contact with the coal and covered it most of the time. Hence it follows; that if the coal has been formed in marshes like our peat bogs, we ought necessarily to admit of a submergence and therefore of a subsidence of the land after each deposit of woody matter, and of an upheaval of the same land to bring it up again above the level of the sea for each successive growth of a new peat bog. This appears to some geologists an unaccountable and unnecessary use of nature's internal forces; a kind of *lusus naturæ*, resembling a miracle. To meet this objection, they have supposed that the peat bogs of the coal measures grew on the deltas of some large river, and therefore exposed to periodical inundations: that as fast as the peat grew, the river brought upon it mud and sand, the materials from which the shales and the strata of sandstone were formed: that, nevertheless, the deltas being by some *internal force* constantly sinking, they were consequently sometimes invaded by the sea which covered their whole extent and in the course of time, built upon them the strata of limestone: that as soon as these strata reached the surface of the sea (a fact which probably supposes that the movement of subsidence had stopped for a while) the land plants began to appear again, the peat to grow, and the matter to be heaped up till another large periodical inundation of the river brought new deposits of mud and sand; and thus by continuous subsidence and repeated inundations, the coal, shales, sandstone and limestone strata were alternately formed.

Before giving any reasons in support of the alternation of upheaval and subsidence as supposed by the peat bog theory, we will take the liberty to examine this new theory which we regard only as a poor modification of part of the former which it assumes to put aside forever. It is generally asserted that in the coal measures, the alternation of strata is the same in the whole extent of a basin, or in other words, "*that each stratum is generally horizontally extended over the whole coal-field in a continuous sheet, so that each seam is accompanied by the same strata above and below.*" This is only partly true. In the coal-fields of the United States, it is true only of some beds of coal and of one or two strata above the conglomerates. Every practical geologist knows well that it is impossible to identify the position of a bed of coal by means of its adjoining strata. If the same strata

had been expanded without alteration through the whole extent of a coal basin, nothing would be easier than to fix at once the geological horizon of each bed of coal after the close study of a single section. The shales above the coal give by their fossils the only reliable data; but in many places they (the shales) are entirely wanting and are replaced by sandstone or limestone. In the western coal-fields of Kentucky, the first coal below the Mahoning sandstone, or the fourth coal above the conglomerates (the same as the Pomeroy coal of Ohio or the upper Freeport coal of Pennsylvania) whose shales sometimes reach in the East a thickness of 10 feet, is immediately covered by the sandstone. There is scarcely a vein of coal worked to any great extent, that does not show a great diversity in the thickness, density and color of its roof shales. Hence the necessity of roofing differently the tunnel of a mine in different places according to the nature of the shales. The bottom clay is almost always present; but its thickness, color and density are also variable. The limestone of the coal is the most irregular of all the formations. It is mostly local, sometimes only in boulders, and its numerous variations in thickness, composition and even fossils, cannot be accounted for by any satisfactory general rule. There is not in the United States a single bed of coal that is unvariably covered with limestone. The sandstone is generally extended with more regularity; but it has also its diversities of thickness and local disappearance. The only bed of sandstone which appears to be continuous in the whole extent of the coal-fields above the conglomerates, is the Mahoning sandstone. Though its thickness is also somewhat variable, it is found topping the 4th coal (coal E of Lesley's Manual) from the anthracite basin of Eastern Pennsylvania to the western extremity of the coal-fields of Illinois and Western Kentucky. The Anvil-rock sandstone, topping the 12th coal of Western Kentucky, though generally of great thickness, has not as yet been identified in the East. For the coal itself, the assertion of its continuity could be admitted as nearly true.

Though a coal bed cannot be called a continuous sheet in its horizontality, since all the strata of coal are subjected to thinning or even entirely disappearing in some places and some others are circumscribed in narrow limits, generally speaking, most of our large beds of coal can be traced through the whole extent of the coal-fields. The great mammoth vein divides itself into three or four different beds in some places, but is found continually, thinning from Carbondale to the western limits of the Illinois coal-fields. The first coal below the Mahoning sandstone (the Pomeroy coal) is seen to have the same extent with scarcely any change in its thickness. The Pittsburg coal which from its high position in the coal measures has been washed away over

large surfaces, shows itself, along with the characteristic fossils of its shales, in every part of the measures where the thickness is sufficient to reach to its level. Thus we have some beds of coal generally accompanied, at least locally, by their peculiar shales, and one great bed of sandstone covering a surface as wide as the whole extent of the Appalachian and the Illinois coal-fields, an area of nearly one hundred thousand square miles.

In a short report on the stratigraphical palæontology of the Geological Survey of Kentucky, or rather in an introduction to a future palæontological report of the Survey of that State, I expressed the opinion that the Appalachian and the Illinois coal-fields were once continuous fields, and that the great axis of the Devonian and Silurian measures which separate them now, had been elevated at an epoch posterior to the formation of the coal. This opinion was not and could not be discussed in a short local report. I could there only give in support of it the fact of the identical distribution of the coal beds and of the coal flora in both basins. As it has been very courteously controverted in this Journal,* and especially as the discussion of this geological point enters into our subject and may help to satisfy the mind upon the value of the so-called new theory mentioned above, it is proper that I should briefly present the reasons in favor of my opinion.

It would be absurd to assert that the veins of coal or rather that the peat bogs of the coal formations were formed on a perfectly horizontal surface, and that the woody matter was deposited in the same thickness over the entire area. The most even plains have undulations on their surface; and the cross-section given in my report of a part of the Dismal Swamp of Virginia, should have explained my meaning. The peat bogs of our time are more or less broken or crossed by small elevations of sand or hills of some other deposit, which here and there break their horizontality and also their uniformity of features. For, although these irregularities may be scarcely elevated above the surface of the bogs, they are without exception, covered with a vegetation of entirely a different character from that of the peat bogs, and therefore their outline is perfectly definite. Sometimes groups of islands are thus seen rising in the middle of the bogs. Sometimes, also, as in the granitic country of the Hartz mountains, or in the basaltic region of the Rhoen mountains of Germany, peaks of granite or columns of basalt protrude like towers from some parts of the swamp. No one will contend that these irregularities break the continuity of a formation; or that the peat bogs on both sides of a hill of sand or around a block of granite are not a *continuous formation*. In a geological point of view, accidents like these cannot be taken into consideration.

* This Journal, vol. xxvi, p. 78, July, 1858.

But it is clear, at least to my mind, that the great ridge of Devonian and Silurian by which the Appalachian and the Illinois coal-fields are separated to a distance of from one to two hundred miles, cannot be regarded simply as one of those hills which separates two parts of a peat bog. We can discuss only these two alternatives: either the Silurian axis was not upraised at the epoch of the formation of the coal, and this formation, being in active progress upon the whole surface occupied now by the coal-fields and the Silurian and Devonian, was *continuous*, and consequently presented the same general features; or, the coal was formed on both sides of the ridge, and therefore in two separate basins, and then both formations, though of the same age, would have been subjected to some peculiar influences, and each of them would be characterized by some differences, either in the relative position of their coal beds, or in the composition of the strata, and especially in the distribution of their flora. The report of the Kentucky Survey shows on the contrary: that in both coal-fields, the coal beds are exactly in the same relative position; that at the same geological level, their shales contain the same species of plants; that from Eastern Pennsylvania to Western Illinois, the thinning of some strata preserves a perfectly regular progression, and does not show any change on one or the other side of the great ridge.

But there are some other reasons which may appear more conclusive.

1. The conglomerates, as also some beds of sandstone, especially the great Mahoning sandstone, are developed near the eastern limits of the coal-fields to a prodigious thickness. This heaping of loose materials, sand or gravel, evidently shows the prolonged action of the sea against its shores. Supposing that the Silurian ridge had been elevated before the formation of the coal, it would have necessarily served as a shore, and we should find somewhere a marked difference in the thickness of the transported materials abutting against it. No geologist has ever seen anything of the kind, and the conglomerates like some beds of coal and of sandstone, go thinning to the west with a constant and uniform decrease.

2. All the peat bogs are formed in basins, as also all the deposits of coal, and the outlines of these basins are of course generally broken and irregular. This fact is observable in the eastern and southern borders of the coal-fields. But on the sides of the coal-fields lying opposite each other along the great axis that separates them, the outline is well defined and unbroken.

3. In a basin where many beds of coal have been successively formed and separated by different strata, some of the upper coal beds must necessarily abut against the walls of the basin, when they are found in their horizontal position. In other words,

by the outward direction of the wall of a basin an upper bed ought to be extended somewhat beyond the lower and cover its margin. It is the case in the western borders of the Kentucky coal-fields, viz. in Christian county and other places, where the 4th coal above the conglomerate or the next bed below it, abuts against the older formation, when the lowest coal has to be looked for farther back towards the centre of the basin. On both the opposite sides of the Appalachian and the Illinois coal-fields, the appearances are different. It is the lowest coal, then the conglomerate, then the sub-carboniferous strata that appear one after the other upon the surface, following a dip corresponding to that of the sides. This undoubtedly shows that they participated in the movement which elevated the ridge that divides them, and that they were formed before its upheaval.

4. The undulations of the surface of the coal-fields, so distinctly marked in the vicinity of the Alleghany mountains that by lateral compression the veins of coal have been upraised in a perpendicular and even in a reversed position, are constantly repeated, though constantly less frequent and abrupt elevations westward. The upheaval of the Silurian ridge appears like one of those undulations, being generally in a direction parallel to the others.

5. The upheaval of the Alleghany mountains and the undulating movement caused by it upon an immense surface of country was very slow, and continued for a long period. The bends or flexures of the eastern coal, especially of the anthracite coal-fields are not jagged and angular, nor are they often broken by faults. The shales are polished by sliding, and rolled as if they had been folded in a soft state. The coal itself presents the same appearance, and at the bottom of the flexures, it is generally, as the miners well know, somewhat thicker than on the raised sides, as if the matter had slipped by its own weight when there was room for a displacement. Hence, it follows that if the undulating movement was slow, and if the strata of the coal measures were still in a soft state and easily removable, the top of the great ridge was necessarily and easily washed away as fast as it was being raised near and above the surface of the sea. No wonder therefore that the remains of the coal strata have not been preserved, and that we scarcely find any trace of them. The total disappearance of the coal washed away by erosion, is, I think, the only objection of any weight that has been or may be made against the opinion advanced in these remarks. But there are in Pennsylvania, in Ohio, and everywhere in the coal basins of the United States, evident traces of vast denudation that may be compared with the washing away of the Silurian ridge, and of which no trace has been left in the subsequent strata of this country.

It would be easy to multiply these considerations and to sustain the position by a number of geological facts. But so much is sufficient for our purpose, and we come back to the question of the formation of the coal. Upon the supposition then that at the time of the coal formations, the Appalachian and the Illinois coal-fields were united in one area, their surface would fairly be estimated at 300,000 square miles. Now, in the new theory presented above, we find it asserted: that the shales and the sandstone of the coal have been deposited upon the surface of the peat bogs of the coal formations by the inundations of some large river! Would it be possible for a sound mind to admit that a river can cover at once or even by repeated inundations, a surface of three hundred thousand square miles with a deposit of sand from six to one hundred feet thick, which is the thickness of the Mahoning sandstone.

Giving to the hypothesis the widest range of probability and considering as a peculiar Delta the area (sixty thousand miles) of the Appalachian coal-fields, still we find no geological phenomena of our time to justify it. Let us compare a few data. The whole plain of the Mississippi, comprising the Delta, from Cape Girardeau, 50 miles above the junction of the Ohio to the sea, covers an area of about 30,000 square miles. Would it be possible to suppose that an inundation would ever cover this whole surface with only a few feet of sand or of mud? According to the observations mentioned by Forshey, the mud transported in one year by the Mississippi river would cover a surface of twelve square miles with one foot of alluvium. At this rate it would take five thousand years for a river as mighty as the Mississippi to cover a single bed of the Appalachian coal-fields with one foot of shales.

Moreover, it is well known that a river cannot spread any of its transported material in a uniform manner, especially not in the deltas which are exposed to continual changes. For a delta is never composed of compact materials. It is mostly cut by variable and sometimes under currents covered only by a crust of vegetation, sustained by drift wood or floating upon the deep and muddy waters. These currents cause constant alterations: extensive marshes sink and are buried to a great depth below the general level of the country; lakes appear in some places and dry up in others; some bayous are filled and others opened. There are few square miles around New Orleans and on the Mississippi delta, that have not been thus subjected to violent disturbances, whose effects will be traced for ages in the most varied and disordered position of materials or stratification, if it can be so called. On the contrary, the stratification of the coal measures is of the most regular kind. The homogeneousness of the strata superimposed on the coal, especially the shales, shows

the total absence of a current at the time of the deposition of the matter. Not only the most delicate parts of the leaves of ferns are preserved in the shales, just as they fell from their supports; but we generally find around the same spot the remains of the same species. A kind of fern of which the deciduous leaflets are generally found separated from the stems (*Dictyopteris obliqua*, Bunb.), in some places completely covers the shales over a surface of from six to ten square feet, and without this space, not a single leaflet of the same species is found. It is evident therefore that the leaves have been buried at the place where the ferns grew and as they were falling from the stems. The slightest current would have made of all the matter a disordered mass in which leaves of every kind would have been mixed, not only in every position, but without regard to the place of their growth.

It is impossible to account for the successive deposits of shales and of sandstone by a river. When an inundation is at its height, it bears with it the heavier materials and these are deposited just as the current subsides. The sand would therefore be deposited before the mud or the sandstone formed below the shales and not above it.

But the deposits of all our great rivers, the Mississippi, the Ganges, the Amazon, the Po, is mud only. Sand is occasionally transported by a river or removed from one place to another by some strong current, but then it constitutes a bank and is generally a local formation of small extent.

All the great deposits of sand in our time, which by their thickness and extent, may give an idea of those which have covered the bogs of the period of the coal, are marine formations. The drift of North America and Northern Europe, our Pine-barrens of the south along the shores of the Atlantic; the pampas of South America, the heaths of Luneburg or sand plains along the southern shores of the Baltic Sea; the sand hills of Eastern Germany and Holland along the shores of the North Sea; the downs of the Gironde and of the Camargue in France; the sandy deserts of Syria, &c. No one of these formations can be referred to the direct agency of a river.

That the sandstone of the coal generally contains no remains of marine animals, does not prove that it is not of marine origin. The sand of our drift scarcely contains any of them. The hills of sand along the shores of the Baltic and the North Sea are almost entirely destitute of shells and animal remains. Sand is not only permeable to the all decomposing oxygen of the atmosphere, but it is a grinding agent, and as it is put in constant motion, either by the waves and currents of the sea, or by the wind, it is not to be supposed that even the shells would be long preserved in the loose materials. Yet in some places, the sandstone of the coal, especially when it is fine and soft, has

preserved the casts of marine shells, though not the remains. I have found them in many places, especially near Athens, Ohio, where a bank of soft sandstone is full of large *Producti* and *Terebratulæ*. But here, as in the sandstone of the lower measures, the animal remains have disappeared, and the mould only is preserved. It is the same with the prints of fossil wood found in the sandstone, which only shows the casts of Lepidodendra, Calamites, Sigillariæ, &c.; with only a thin lamina of carbonized bark, the whole substance of the wood having disappeared, except where silicification has taken place. This shows why the fossil remains are so rare in the sandstone, since even a cast can scarcely be made on loose sand.

In the shales of some beds of coal, especially in the southwestern part of our coal-fields, the remains of marine shells abound: some of the species are supposed to have lived in brackish water; but most of them like the fishes found in connection with them, appear to be true marine species. And what at first may look like an anomaly which will be explained hereafter, these marine remains are sometimes more or less mixed with leaves of ferns or land plants, and scarcely if ever with true marine plants or Fucoids. Thus, also, from palæontological evidence, the shales cannot be considered as deposits of a river any more than the sandstone.

The fact that the limestone of the coal measures cannot be thus disposed of, is fatal to this new theory. Its marine origin is evident and must be accounted for. And as the ocean cannot be swollen, like a river, it is necessasy to admit of a subsidence of the land for its submersion in the sea. But the supposition of a continual subsidence of a vast country is truly as violent an hypothesis as the supposition of an alternation of upheavals and subsidences of the same country, and the difficulty to account for the first proposition is far greater. Geological forces are not acting forever in the same way. It is now generally acknowledged that mountains have not been upraised in a single movement, but by a succession of gradual efforts, or by epochs of upheaval succeeded by epochs of rest, and consequently of subsidence; since a diminution in the activity of the internal forces cannot but cause a depression by the natural resistance or the weight of the upraised masses. We find proofs of such alternate changes of level at the present time; the movements of the ground about the temple of Serapis, so clearly explained by Lyell; the appearance and disappearance of some islands, &c., and especially in the stratification of our recent formations. The coal of the Miocene epoch was also formed by peat bogs upon an upraised land. The shales contain leaves of different species of trees of which the congeners are found in tropical regions. These shales are covered by successive strata of conglomerate, sand-

stone, and limestone. The coal and the lignite of the Pliocene epoch have been formed in the same way. Their shales contain remains of land plants, and sometimes also they are alternately covered by sandstone and limestone. The drift which is extended over the whole is as evident a marine formation as the limestone itself, and now it is in some places more than seven hundred feet above the level of the ocean. Is not this succession of land, freshwater and marine formations, in perfect accordance with the alternations of the strata of the coal measures, and can it be explained in any other manner than by the oscillation, the upheaval and subsidence of the land which supports these formations?

Even if the theory of continual subsidence could find in recent phenomena anything favorable to its support, it would be impossible to understand how a long protracted downward movement, especially of a Delta, would effect the repeated formation of coal beds; how the land being completely covered by the sea for the formation of the limestone, could be dried up again, so that the formation of the peat could begin anew, upon its whole surface. The river, says the theory, was still filling up again the whole space, while the madrepores were building the limestone. But this is pure speculation which is equally contrary to reason and to geological facts. For, if it is true that from causes which have not yet been clearly explained, the delta of the Mississippi is slowly subsiding, it is probable that if the subsidence was once active enough to permit the invasion of the sea over its whole surface, the soft matter, sand, mud and peat, of which it is composed, would be washed away by the marine currents, the tides, the waves, &c.

In the Report of the Geological Survey of Kentucky, I expressed an opinion which does not now perfectly satisfy my mind. I supposed that after the formation of extensive peat bogs, the subsidence of the land being at first very slow, the first result of the downward movement was a general inundation either of marine or of freshwater or of both mixed together. A depression of only a few feet of the great swamps of Southern Virginia would bring upon them by-and-by the waters of the surrounding rivers and also some water from the sea, either percolating through the sand or finding its way by some friths between the hills of sand extended along the shores. This supposition fully explains the formation of shales covered in some places with marine shells and remains of fishes mixed with land plants of the peat bogs. For, these plants, especially the ferns, mostly growing upon the thick and high rootstocks could still live in the swamps invaded by marine water. It explains also the local formation of the limestone in some depression of the marshes or marine lakes. But I supposed that after this period

of slow subsidence, the downward movement becoming more rapid, the sea broke through its sandy barriers and swept at once upon the whole plain, bringing with it the sand of its shores for the formation of the sandstone. I do not find this last supposition necessary. For, even with a slow movement of subsidence, continuous for a while, the sea ought to penetrate to the interior of the land, and with its continuous encroachments, bring forward with it the sand of its shores. This would better explain why some strata of coal and sandstone are thicker westward, where the bogs grew for a longer time and where the action of the sea was afterwards prolonged. It explains, also, why to the westward some veins of coal are double and generally more numerous than to the southeastern part of our coal-fields, this multiplication being caused by partial retrocession and advance of the marine element, which was felt only near the inside of the coal-fields and did not reach the deeper outside borders of the original basin. But there is no material difference between these explanations. In either case the repeated upheaval of the sea-covered land is supposed as a necessary condition of the formation of the peat; for this matter can grow only upon land where the water of the sea cannot reach.

To this last assertion which has not been contradicted, we can add the following: that peat never grows on swamps that are annually or periodically flooded by river water. Examining the swamps of the Mississippi, the theory says, that though covered annually by inundations, they are entirely untouched by river mud: that those favored spots are surrounded, particularly on the side next the river, by dense vegetation, which acting as a sieve, completely strains the mud from the water before it reaches the peat swamps. The water of these swamps is therefore pure, and pure peat has been deposited there for ages. Contrary to this authority, I must be permitted to say that during about thirty years of explorations in the peat bogs of Europe and of the United States, I have never seen the peat growing in places exposed to the inundations of a river. On this subject, there is better authority than my own. De Luc, in the beginning of this century, was the first to remark that along the banks of some rivers, the Elbe, for example, there were formed extensive beds of peat, which appeared to be lower than the water level of the river at the time of its inundations, and that nevertheless they were not covered by water, but by a peculiar vegetation which by its decomposition furnished the essential constituent of peat. In the prosecution of his researches, he observed that along these bogs the bed of the river was bordered by a natural embankment, which even in the highest rise of water prevented it from reaching the peat bogs. This damming up was fully explained by his remark: that at the time of the inundations and

when the water was most loaded with sediment, the heaviest particles of muddy matter were deposited all along on both sides of the river, just where the current began to lose its force; and that by this process, continued for a long period of years, a natural dam being built along some rivers, the marshes on both sides of it, and formerly inundated, were eventually put out of reach of the inundations. I have myself ascertained that the thin particles of sediment which were at first deposited upon the marshes, formed an essential preparation for the growth of the peat, viz. an impermeable basin, and that it was only when this basin was entirely isolated and protected against inundation that the plants of the peat bogs began to appear and the peat to grow. This process explains the formation of the fire-clay which underlies every bed of coal.

The true peat bogs of the Mississippi delta are mostly located on or near the old shores of some crooked bayou and surrounded on all sides by a kind of embankment. Thus they are free from the influence of river water which, though clear, would stop the growth of the peat, by destroying the peculiar vegetation of the bogs.

The action of the water in building its own banks along the principal bed of a river is beautifully exemplified in the United States, especially along the Mississippi and some of its tributaries. Both sides of the Minnesota river are thus bordered by extensive marshes which cover the bottom land to the base of the ridge of the prairies. In spring they are filled with water, while the banks of both sides of the narrow channel are mostly dry still high above water. It is then very difficult to cross those marshes from the river to the prairies or to land from a steamboat. Seen from the top of some hill near by, the Minnesota then appears like three different rivers running parallel and separated only by two narrow strips of land overgrown with trees. In the summer time, the marshes are mostly dry, overgrown with sedge and some willows; but no peat bogs have till now appeared in any part of their whole extent, because the separation from the river is not yet complete and because they are still exposed to annual inundations. In Minnesota, the peat bogs are found upon the prairies, near or around lakes without outlets, and on the banks of the upper Mississippi under the same circumstances as on the lower, viz. in such places as are beyond the reach of inundations. We may have occasion to extend these remarks farther when we come to consider the nature of the vegetation of the peat bogs.

In spring, at the time of our periodical inundations, the plants growing on the marshes of the Mississippi and along its shores are mostly lying flat upon the ground in a state of partial decomposition. The high canes only (Arundinaria) rise above water. And as they mostly bear their branches and leaves near

the top of the stems, or above water, these stems can not help much in the process of purifying the muddy water. Yet it is true that it becomes clear towards the interior of the marshes, but only as fast as the current becomes insensible or the water still.

Mr. Lyell has been quoted as authority for many assertions for which he can scarcely be held accountable, or at least for the conclusions which are drawn from them. Thus the *new* theory of the formation of the coal tries to find support in a geological assertion of the celebrated English author, an assertion that I do not recollect to have read in any of Lyell's works and which would truly show too much of ignorance of the palæontology and even of the strata of the coal measures. It is this: "In the sandstone of the coal formations, it is customary to find trunks of trees, but only trees, no small branches, leaves or tender parts. And these trunks are observed to be mostly pines, highland trees, while the trunks of the coal seams proper are Sigillariæ, Lepidodendra, Calamites, swamp trees, &c." From this, the new theory concludes: that the trunks are the remains of drift timber brought by the river from the high lands.—As if the sea could not and did not float timber as well as a river!

But it is not with the conclusion that we have to deal now, but with the assertion, erroneous in every point.

1. The trunks of trees are by far more rarely found in the sandstone of the coal than the small fragments of leaves, branches, &c. Some strata of sandstone, the Mahoning sandstone and others of the low coal measures, are sometimes entirely blackened by those small fragments of plants so bruised that it is scarcely possible to identify any species. This is not a local appearance; but it is observable in the whole extent of the coal-fields generally on the same stratum of sandstone. This shows a rapid movement of the sea, which sweeping with impetuosity upon the peat bogs of the coal, washed away part of the decomposed plants and peat bogs and mixed them with the sand.

2. Representative species of the Pine family have scarcely been found in the true coal measures. In the family of the *Cupressineæ* which has more than sixty species of fossil plants distributed in twenty genera, there is not a single species belonging to the coal epoch. In the family of the *Pines* which has at least one hundred and fifty fossil species known, distributed in twelve genera, there are only thirteen species which have been referred to the true coal measures. Two of these, *Peuce Hugeliana* Ung. and *Peuce australis* Ung., belong to uncertain formations of coal of Van Diemen and Vanguroë Islands. Of two other species, one, *Dadoxylum Beinertianum* (Endl.) belongs to the limestone (not to the sandstone of the transition epoch), the other *Dadoxylum Sternbergii* Endl. was wrongly ascribed to the coal and be-

longs to the Miocene of Haering in Tyrol. A fifth species, *Pinus anthracina* Ll. and Hutt., is a cone which was found in the *shales* of England. There are then only eight species of the pine family which have been found in England, in a bed of sandstone referred to the upper coal measures and described by Witham.

Admitting the position of this sandstone as true, though it is most remarkable that the remains of the Pine family should have been found in the coal measures of England only, there has been found in the sandstone of the coal measures 4 species of *Stigmaria*, 15 species of *Sigillaria*, 10 species of *Lepidodendron*, 3 of *Knorria*, 4 of *Halonia*, 6 of *Calamites*, 10 to 20 species of *Psaronius* and other stems. This would make at least 60 species outside of the Pine family for 8 in it. The same proportion would be true according to the number of specimens. In the state of Ohio, near Athens, there is perhaps the most extensive deposit of transported silicified trunks that it is possible to find anywhere. Of some thousand specimens that I have examined, all belong to the genera *Sigillaria* and *Psaronius*. A single specimen which is not yet determined has concentric circles, and may belong to the genus *Araucaria*.

From recent observations, it appears that the genus *Sigillaria* is related to the *Isoetes* of our time, a water plant. All the *Psaronii* are trunks of ferns and like the other genera quoted above, they all belong to the flora of the true coal formations, and are found in the shales also. Nevertheless, this does not put aside that part of the assertion: that some trees of the sandstone might have been transported from a dry land. It is a complicated question which may be examined at another time.

(*To be continued.*)

Art. IV.—*Some Remarks upon the use of the Microscope, as recently improved, in the investigation of the minute organization of Living Bodies;* by H. James Clark, of Cambridge, Mass.

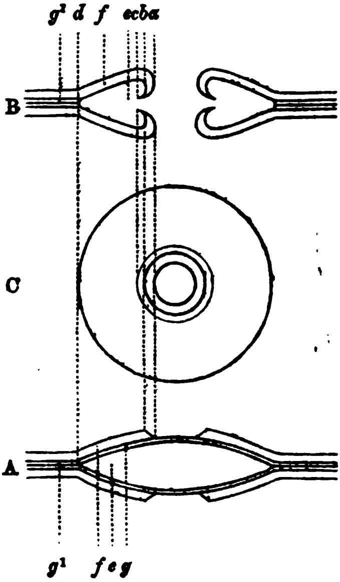
[From the Proceedings of the American Academy of Arts and Sciences, Boston, Mass., January 26, 1859.]

I was incited to bring together my thoughts and experiences upon this subject, by discovering, three or four months ago, a novel feature in the so-called glandular dots of the wood of our common White Pine (*Pinus Strobus*, Linn.).

A dot of this kind is usually represented by a circle (fig. 1, C, *d*), in the centre of which is a single or double ring (*a*, *b*), which has about one third the diameter of the first (*d*). The outer circle (*d*) is described as the boundary of a lenticular space (A, *e*) between two *contiguous cells*, and the inner double circle (C, *a*, *b*) as the outskirts of a perforation (A, *a b*) in the deposit layer (*f*)

of the cell. The double circle arises, as is said, from the fact that the perforation has the shape of an extremely short truncate cone, which, when viewed endwise, presents to the eye its two circular ends concentrically; the broader end, which is always next the interior of the cell, corresponding to the outer (*b*), and the narrower end to the inner circle (*a*). Thus are these dots described and illustrated, by Mohl, Schleiden, and Schacht, as seen in the common European Pine (*Pinus sylvestris*), and thus did they always appear to me, not only in that species, but also when I observed them in *Pinus Strobus*, except with this difference, that the perforation was bounded by an exceedingly faint third circle, (C, *c*,) whose relations I could not comprehend, nor was I able to reconcile its presence with the theory in regard to the nature of the perforation. I therefore left it, doubtingly supposing it to be some optical illusion. The microscope which I used, and which I have been in the habit of using up to within the last six months, is an Oberhaeuser's, made for Prof. Agassiz some years ago; and yet at this very day I find it as good, with perhaps a single exception, as any now made in Germany, and therefore just as trustworthy in the investigation of the glandular dots of the Pine.*

Fig. 1.



* It may not be uninteresting to state here, that the first great microscope made in Germany was constructed in 1829 by Fraunhofer, for Professor Agassiz. This microscope was represented in a copper-plate engraving, and described by Döllinger in the Memoirs of the Munich Academy for 1829, or 1830. In January, 1831, Agassiz went to Paris, and having given unlimited orders to Oberhaeuser for the best microscope that could be furnished, according to the knowledge of those times, he received from that maker, in 1832, an instrument which has not been surpassed in all Germany to this very day; at least, I have never seen any work from the hands of the best observers there, whether zoologists, histologists, physiologists, or botanists, which could not have been accomplished just as well by this microscope. There may be one exception to this of a very recent date, but I am acquainted with the instrument only through report. With this masterpiece of Oberhaeuser, Agassiz has gone on to this time, doing his great work with remarkable success, as all the world knows. Of late years it has become evident to Agassiz that his instrument was not equal to the demands which the progress of his researches put upon it; that there was something beyond its reach, of which he now and then could get a glimpse, just enough to warrant him in the belief that the study of the intimate structure of organized bodies had hardly begun.

So long ago as 1852 he had opportunities to see the workings of an instrument of the English pattern, made by Spencer; and although it was known as a rival of, if

For the last six months I have used one of the most recently improved microscopes, made by Mr. Charles A. Spencer of Canastota, N. Y.; and with this, between three and four months ago, I again attempted to solve the mystery of the glandular dots. This I did with the most complete success.

When the focus was brought to bear upon the inner surface of the dot, the innermost ring (B, C, *a*) of the perforation appeared first; a little deeper, the next outer one (*b*) came into view, whilst the innermost (*a*) disappeared; and still deeper the last (*b*) passed from my sight, and the faint ring (*c*) of my old observations came out sharply and clearly, as an exterior circle to the two others.

I also observed, when passing from the innermost circle (*a*) to the outermost (*c*), that the widening was gradual; and so, too, did it appear in the transit from the second ring (*b*) to the outermost (*c*). This gave me the clew to the whole structure. I saw that these rings were not the expression of a simple perforation, but of the outwardly curled edge of this aperture, shaped in such a way as to form a sort of trumpet mouth.

Although I would not trust to a transverse section alone, yet I found that it confirmed me in my views as explained above. The figures which I have given,—namely, a transverse section (B) with dotted lines projected upon a face view (C) of the dot, —I think will suffice to illustrate what I believe to be the true relations of these rings.

Now, why was it that the Oberhaeuser instrument would not divulge these relations, when the microscope of Spencer succeeded so satisfactorily? This I will explain by showing the difference between the objectives of the two microscopes. I will compare the action of the objective of Oberhaeuser to the manner

not superior to the Transatlantic microscopes, he did not become convinced that it came up to his requirements.

Two or three years later I had the pleasure of bringing to his notice the results of some of my own researches upon the value of recently constructed objectives of English make. This gave him renewed hope, and, having heard of Spencer's continued rivalship and growing superiority, he determined to test his skill to the utmost. He therefore, in 1857, requested me to visit Canastota, in order to consult Spencer, and advise him as to the nature of the work for which we wished to use his instrumeuts. This consultation resulted in the conclusion that we must have three sets of objectives;—one with the extremely flat field; a second of the like kind, but so put together as to allow working with it plunged in water; and the third with a depthing focus extending as far as possible beyond that of the ordinary kind, for the purpose of viewing objects as a whole, in order to ascertain the relations of their different parts. And Spencer is now devoting those extraordinary abilities which show him to be a man of genius, to the construction of a microscope which shall embody not only the optical excellences of the different systems of lenses required for the various modes of investigation, but also those conveniences of mounting which the long use of that instrument has taught us, to facilitate the researches upon the living being in its normal condition, and in its element, that we may be no longer compelled to represent the tortured figures of a crushed body or dismembered organism.

in which a plano-convex lens treats the rays of light which pass through it, from any object. Those rays which pass near its axis are brought to a focus at the farthermost possible point from the lens, whilst the rays which pass through the periphery are converged at a much nearer point, and between the axis and periphery there are all degrees of convergence. The difference between the farthermost and nearest points of convergence may represent the distance or depth through which the objective takes cognizance of things, and will account for the fact that I saw all the rings of the Pine-dot at one time.

The action of the objective of Spencer's microscope may be compared to that of a parabolic lens, which converges all the rays of light to one absolute plane, and therefore forms what is called a *flat field*.

Now out of this field, either above or below its horizon, it is not possible to see anything, and on this account, when the innermost ring (B, C, *a*) of the dot was in view, the others were not to be observed; and when the field was lowered to the second ring (*b*), the innermost one (*a*), being above the horizon of the field, was invisible; and, again, when the outermost and lowest ring (*c*) was reached, the middle one (*b*) also vanished.

Were this outermost ring as distinct as the others, it might have been possible to detect its relations by means of the Oberhaeuser; but since it is the exceedingly delicate, reverted edge of the perforation, the narrow aperture of this ordinary objective does not admit sufficiently oblique rays to define it, to say nothing of its being confused with the other rings which are in view at the same time.

I would here remark that this peculiar structure is most frequently to be observed in old wood, when the cell-wall (B, g^1) has also become perforated, and even has retreated from the deposit layer as far back as the edge of the lenticular interspace. In young wood the perforation corresponds with the figures usually given. I have used this discovery, not only to show how little may be understood of the structure of a familiar and much treated of body, but also as a preliminary illustration of the exceeding value of a flat field and a wide angle of aperture in microscopic investigations.

But this is not the first example which has occurred to me. As far back as a year ago last summer I visited Mr. Spencer, and spent several days with him in testing his objectives with the tissues of every creature which we could find. I shall never forget the astonishment and delight with which I occupied day after day, plunged into the hitherto unknown depths of organic life. I say this after having tested from time to time some of the best English microscopes which have been made since the "Great Exhibition," and therefore am not to be supposed to

have made so great a leap as if from an Oberhaeuser to a Spencer. Since that visit, and another one also, made last summer, when I obtained one of Mr. Spencer's quarter-inch objectives, with an angular aperture of one hundred and forty-five degrees, I have from time to time made particular efforts to test the value of the flat field and wide angle in the study of organized bodies. The results of my investigations at Canastota, and also since my return, I have embodied in this paper.

One of the most valuable properties of the flat field is, that it enables one to study an isolated cell, in a manner totally unexpected to me, making it possible to obtain a section of such a body at any horizon, as if it were actually cut across. As I have said before, the flat field ignores everything above and below its horizon, and therefore, if it is brought on a level with the equator of a spherical cell, the largest possible circle is obtained, and the actual thickness of the wall becomes apparent; and if it is raised or lowered, the circle grows smaller and the wall seems thicker, because of the obliquity of the section, and yet appears as distinct as the one at the equator. This may go on until the field approaches very closely to the upper or lower side, and then the inner surface of the cell appears. In an ordinary microscope, the far-reaching power of the objective utterly precludes the possibility of such a process of investigation.

The relations of the Purkinjean vesicle to the yolk, and the number and position of the Wagnerian vesicles, have always been difficult subjects to work out with the ordinary microscope. If the Wagnerian vesicle was situated at the upper or lower side of the Purkinjean vesicle, it has often been next to impossible to tell whether it might be really within the latter, or was one of the very similar yolk-cells outside. There are many other instances of the like kind too numerous to mention. All this difficulty I have seen obviated by the decided, section-like precision of the flat field, which at once revealed to the eye the exact and relative level of every vesicle or yolk-cell.

I was most forcibly reminded, not long ago, of the value of the wide angle of aperture, and the accompanying great amount of light, upon trying Spencer's objective upon the stem of a well-known Hydroid, the *Clava leptostyla,* Ag. In the manuscript of the forthcoming volume of Professor Agassiz's "Contributions to the Natural History of the United States of America," the outer wall of this Hydroid, and of several others, I may say in passing, had been described as a structureless membrane; but what was my surprise, in my last attempt, to find that this wall was composed of a layer of polygonal cells, as distinct as any in the other parts of the animal, and even readily discernible in the more opaque parts, where the stem appeared like a simple black surface under the ordinary microscope.

In regard to the usually estimated worth of wide angles of aperture, I would say, that, from numerous experiments upon living tissues, objectives having this property are valuable, not so much because they can admit extremely oblique one-sided rays, but because they allow rays to enter from all sides at a very wide angle to the axis. One-sided oblique rays throw the shadow in a great measure, beyond any particular cell upon its neighbor, and this produces distortion; whereas when the rays converge at a wide angle, each cell becomes strongly marked at its periphery by a dark, broad shade. A moderately oblique, one-sided light, hardly twenty degrees from the axis of the objective, always appeared to be the most frequently serviceable. I was surprised one day to find that the hitherto faintly visible circulation in the cells of Spirogyra was rendered, by such a light, very distinct, and the granules borne along in the current appeared like little specks with a very sharp, thick, black outline.

At first thought, there would appear to be an insuperable objection to the wide angle of such objectives, and that is the shortness of the working distance, which will not allow one to take anything more than a superficial view of a body, even of moderate thickness. But this objection has not the least force, and, on the contrary, the more nearly absolutely flat the field is, especially in the lower powers, such as the $\frac{1}{3}$, $\frac{2}{3}$, and 1 inch, the better will they bear the use of the higher eye-pieces. This is not a speculative suggestion, for I have been told by Mr. Spencer, that he has been able to see the lines upon *Pleurosigma angulata*, with a one-inch objective of his make. Now nothing but the enormously wide angle and the remarkably flat field which he has introduced in such a low power, could enable one to solve such a finely marked Diatom. Only a few years ago this little unicellular plant was a test object for the highest powers of the best microscopes.

But if this image, or the image of any minute body, is to be magnified to any extent which may be required, by the use of the higher eye-pieces, the latter must be most exquisitely corrected, as regards their spherical and chromatic aberration, or else everything comes to the eye in a distorted state. On this account the Huyghenian ocular is not fit to be used, since it lacks just what we need here. I have for several years past asserted that the next step in the increase of the magnifying powers of the microscope would be accomplished by the construction of a new form of eye-piece, which would augment the image formed by the objective to an almost unlimited extent. At last I am happy to find my prediction verified, in the most practical manner, by the "orthoscopic ocular" invented by Spencer. With such a range of powers, then, there is hardly any body of moderate transparency, but what may be minutely investigated to its

very core. If a subject is too thick for the short working distance of the higher powers, a lower objective may be used, and the higher oculars applied to make up the deficiency. Of course I do not mean to say that a certain amplification obtained by a low objective and a high orthoscopic ocular is fully as good as the same afforded by a higher objective; but in case the latter cannot reach a certain internal structure, the former can be used, with very little appreciable difference, and is by far better than the usual methods employed in such cases, such as pressure or dissections and the isolation of the organ to be investigated.

I have not had an opportunity to make frequent use of the "orthoscopic eye-piece;" but Mr. Spencer has furnished me with another form of ocular, the "solid eye-piece," invented by his pupil, Mr. Tolls. This, Mr. Spencer tells me, so closely approaches the "orthoscopic eye-piece" in quality, that none but a very experienced eye could detect the difference, and the former excels the latter in the admission of light, because it has fewer reflecting surfaces. With this ocular and a quarter-inch objective I have run the magnifying power up to two thousand diameters, with wonderful results which fully justify me in saying all that I have in regard to the study of thick tissues with low powers having wide angles of aperture.*

I will take a young fish as an example to illustrate the remarkable efficiency of the flat field. In a view from above, one may see no less than six or seven different layers or sets of organs resting one over the other; first the skin and the muscular layer, next the vertebræ, within these the spinal marrow, and below the latter the chorda dorsalis, and close to this the dorsal artery, then the intestines and their appendages; and yet every one of these may be plunged through and totally ignored, on account of the peculiar properties of the flat field, and the last, the intestines, minutely inspected, not only cell by cell, but each cell may be studied, in every particular of detail, as if it were isolated. And so may any set of organs be treated, whether situated above or below in the animal. With such means at hand, as long as cells may be seen with a very moderate light, it is utterly preposterous to trust what may be worked out by separating these organs from the animal, piecemeal. When intact, every cell may be measured, not only transversely, but also with the greatest nicety in a perpendicular direction, by the

* In this connection I would urge upon students the necessity of avoiding the higher powers of the microscope in the commencement of their studies. When they have learned to use the lower objectives, it will be a much easier matter to master the higher ones. Students usually suppose that they can see everything with the higher powers, whereas they are greatly mistaken; as much as one would be who should make a minute inspection of the stones of some great architectural pile, and then think he had obtained a proper conception of its magnificent plan and glorious proportions.

micrometer screw, which works the fine adjustment of the objective; every cell, indeed, may be treated as if it were a separate body; but who would warrant to measure, for instance, the size of the cells of a nerve after it had been removed from its natural position, and with more or less inevitable distortion? Unfortunately, investigators have been compelled to do this too often, up to this very day; but now I hope for much better and more trustworthy results.

In embryology, how beautifully this almost transcendental definition of the objective applies! All the cells of an embryo of a certain age may be represented by a circle, with a smaller circle within known as the mesoblast (nucleus). At successively later ages we find the cells of the nerves, for instance, simply oval, as the first step to elongation; next they are in rows; then the ends in contact are without walls, so that each cell opens into its neighbor; and finally, all trace of the separate cell-wall is lost in the straight sides of the nerve tubule, with nothing but the mesoblasts to indicate the original position of the cells. In the chorda dorsalis, intestines, vertebræ, muscles, &c., similar and apparently gradual changes have been observed; but each step, in most instances, was investigated isolately from the previous one, and the intervening space bridged over by the process of inductive reasoning alone. This is not enough; now we know that every second of the life of a cell, or series of cells, may be traced most minutely, minute by minute, hour by hour, and day by day. Day and night, watches have been kept by observers in other departments of science, and why may not the naturalist do so? In some cases a very extensive series of changes may be observed in a short time; for instance, in the embryo of the common Bream (*Pomotis vulgaris*), which Prof. Wyman has observed to pass from the segmenting of the yolk to hatching in the space of about forty hours. It is not possible, in any way, to trace the gradual metamorphoses of cells and organs, except upon the living body; otherwise, every observation is a record of a detached fact, and no more; every bit of an organ is subjected to all sorts of manipulations to bring out what too often is not there according to the laws of the living being. Reagents at one time, and pressure at another, reveal, not the truths of nature, but our carelessness and presumption. I have in mind a remarkable instance of the evils of the almost monomaniacal habit of using pressure whilst investigating tissues. A celebrated physiologist, in all probability, missed the most fortunate chance of discovering the key to the whole history of the mode of origin of the embryo from the yolk-cells, simply by using a bit of thin glass to cover the object on his glass slide. Just before the segmentation of the yolk, the full-grown yolk-cells of birds, turtles, if not of all scaly reptiles, and

sharks, are very thin-walled, hyaline, globular vesicles, each one of which contains a more or less darkened mesoblast, and within the latter are a certain number of entoblasts (nucleoli). Now under the least pressure, the cell-wall bursts quickly, and the mesoblast becomes fissured or wrinkled. In this condition the mesoblast was figured and described as the yolk-cell proper, by no less careful an observer than Johannes Müller. Now in the turtle, at least, the mesoblast undergoes self-division until there are innumerable mesoblasts in the parent cells; and after the latter have congregated to form the different layers of the incipient organs of the embryo, and burst, the former unite side by side, and thus become the original cells of the young tissues.

I feel that I cannot urge too strongly the utmost necessity of studying living beings as nearly in a state of nature as is possible; to attempt this by all available means and contrivances, and, above all, patiently, not begrudging the time, because more numerous observations might be obtained by making a piecemeal and hurried show of dismembered Nature.

It would certainly be more profitable as far as living beings are concerned, if the whole world of science should, for a while at least, investigate exclusively the few transparent animals that may be obtained, than work over the numberless opaque ones which require the dissecting-knife. The first having been investigated, the knowledge of them would assist us the better to interpret the features and relations of the tissues, which we would be obliged to study in a disconnected state, just as fossils are recognized and restored by the comparative anatomist after a careful research among living models.

I have been anxious to present this communication, and to have it recorded, because certain microscopists, who are considered as high authority both in England and in this country, have attempted to depreciate the value of the flat field and wide angle of aperture in the study of living objects. This is a little remarkable, since it comes from a country where, until recently, the most finished microscopes of this kind were made, and where they are now to be found in large numbers. I will read a few passages, which may be found on page 196 of Dr. Carpenter's work on the microscope. He says:

"The author feels it the more important that he should express himself clearly and strongly on this subject, as there is a great tendency at present, both among amateur microscopists and among opticians, to look at the attainment of that 'resolving power' which is given by angular aperture, as the one thing needful; those other attributes which are of far more importance in almost every kind of scientific investigation, being comparatively little thought of; and he therefore ventures here to repeat the remarks he made upon this subject, in his recent Presidential address to the Microscopical Society, of the correctness of which he has been

since assured, by the approval of many of those who have most successfully employed the microscope in physiological investigations: 'The superiority in resolving power possessed by object-glasses of large angular aperture is obtained at the expense of other advantages. For even granting that there is no sacrifice of that most important element, *defining* power (which can only be secured, with a very wide angle, by the utmost perfection in all the corrections), yet the adequate performance of such a lens can only be secured by the greatest exactness in the adjustments. Only that portion of the object which is *precisely* in focus can be seen with an approach to distinctness, everything that is in the least degree out of it being imbedded (so to speak) in a thick fog; it is requisite, too, that the adjustment for the thickness of the glass that covers the object, should exactly neutralize the effect of its refraction; and the arrangement of the mirror and condenser must be such as to give to the object the best possible illumination. If there be any failure in these conditions, the performance of a lens of very wide angular aperture is *very much inferior* to that of a lens of moderate aperture; and, except in very experienced hands, this is likely to be generally the case. Now to the working microscopist, unless he be studying the particular classes of objects which expressly require this condition, it is a source of great inconvenience and loss of time to be obliged to be continually making these adjustments; and a lens, which, when adjusted for a thickness of glass of $\frac{1}{100}''$, will perform without much sensible deterioration with a thickness either of $\frac{1}{80}''$ or of $\frac{1}{120}''$, is practically the best for all ordinary purposes. Moreover, a lens of moderate aperture has this very great advantage, that the parts of the object which are less perfectly in focus can be much better seen; and therefore that the relation of that which is most distinctly discerned, to all the rest of the object, is rendered far more apparent. Let me remind you, further, that almost all the great achievements of microscopic research have been made by the instrumentality of such objectives as I am recommending. There can be no question about the large proportion of the results which continental microscopists may claim, in nearly all departments of minute anatomical, physiological, botanical, or zoological investigations, since the introduction of this invaluable auxiliary; and it is well known that the great majority of their instruments are of extremely simple construction, and that their objectives are generally of very moderate angular aperture. Moreover, if we look at the date of some of the principal contributions which this country has furnished to the common stock,—such as the 'Odontography' of Professor Owen, the 'Researches into the Structure of Shell' carried out by Mr. Bowerbank and myself, the 'Physiological Anatomy' of Messrs. Todd and Bowman, the first volume of the 'Histological Catologue' by Prof. Quekett, and the 'British Desmideæ' of Mr. Ralfs,—we find sure reason to conclude that these researches *must* have been made with the instrumentality of lenses, which would in the present day be regarded as of very limited capacity.—I hope that, in these remarks, I shall not be understood as in any way desirous to damp the zeal of those who are applying themselves to the perfectionizing of achromatic objectives. I regard it as a fortunate thing for the progress of science, that there are individuals whose tastes lead them to the adoption of this pursuit; who

stimulate our instrument makers to go on from one range to another, until they have conquered the difficulties which previously baffled them; and then apply themselves to find out some new tests, which shall offer a fresh difficulty to be overcome. But it is not the *only*, nor can I regard it as the *chief* work of the microscope, to resolve the markings upon the Diatomaceæ, or tests of the like difficulty; and although I *should* consider this as the highest object of ambition to our makers, if the performances of such lenses with test-objects were any fair measure of their general utility, yet as I think that I have demonstrated that the very conditions of their construction render them inferior in this respect for the purposes of ordinary microscopic research, I would much rather hold out the reward of high appreciation (*we* have no other to give) to him who should produce the *best working microscope*, adapted to all ordinary requirements, *at the lowest cost*."

Notwithstanding the approval of those, as Dr. Carpenter says, "who have most successfully employed the microscope in physiological investigations," I do not hesitate for a moment to declare, that nothing could be more pernicious to the best interests of science than these remarks. It is unfortunate that such mistaken views should be displayed on this subject, where so great confidence has been placed,—by one, too, whose elementary works on physiology have raised the belief, among many, that he is perfectly conversant with those very tissues which require the nicest and most rigid microscopical investigation.

The illustrations which I have given of the great value of highly corrected lenses in the study of minute structures, are sufficient, I think, to refute these views; but I would like to say a few words more in conclusion, especially in reference to the general relations of microscopical investigations to other departments of natural history.

To say that objectives with a wide angle of aperture and a flat field, are needed for only a few bodies, such as test-objects, like the Diatomaceæ and other known difficult subjects, is to ignore the whole great department of histology, and by that to refuse physiology one of the most important aids; in fact, an aid which, with the help of better microscopes, in future, is likely to take the lead in the determination of the laws of animal and vegetable life. I am well aware that the study of histology has been pursued with the ordinary instruments, of the German pattern, in a great measure; but knowing what these have done both in Europe and in this country, and having discovered, by a few glimpses, how much more, and how much better, we might have done, had we possessed one of these highly finished instruments, I can confidently assert, that it is a grave error to tell opticians they had better devote themselves more particularly to the improvement of the ordinary instruments, and let their transcendental corrections of widely gaping objectives serve in the mean while as playthings for curious amateurs.

But it is a still more serious mistake to say to students, that an instrument which performs under a variety of circumstances "without much sensible deterioration" is practically the best for all ordinary purposes.

So thought Ehrenberg, and yet we all now know what curious mistakes he made. Embryology, too, comes under this proscription; for any one who has attempted to trace the development of animals, especially the lower forms of life, must know that it is impossible to separate the study of their cellular structure from the investigation of their organs.

I cannot more fittingly conclude this communication, than by quoting, by Mr. Spencer's leave, a portion of a recent letter of his to me. He says: "It seems to me that there is every reason to hope much from the earnest application of high powers with large angles. So blind and inveterate has been the prejudice in favor of low powers and small angles, in histology, that younger and less prejudiced microscopists have a comparatively untrodden path before them. Every day's thought convinces me more and more deeply of the radical mistake that has been made in this direction. I have recently been making some observations and experiments with low angles on certain well-known structures, and have in several instances been struck with a blank astonishment at the utterly false, though apparently reliable, results obtained. It happens, too, that the physical and optical characters of those tissues which, oftener than any others, are the subjects of your study, are precisely such as will lead to the most frequent errors; and if you do not find that many a blunder has been made in their study, heretofore, I shall be greatly surprised."

ART. V.—*On Brewsterite;* by J. W. MALLET.

TWO analyses of the mineral species Brewsterite are on record, those of Connell* and Thomson,† both made many years ago. The results were:

	Connell.	Thomson.
Silica,	53·666	53·045
Alumina,	17·492	16·540
Baryta,	6·749	6·050
Strontia,	8·325	9·005
Lime,	1·346	·800
Water,	12·584	14·735
Peroxyd of iron,	·292	.....
	100·454	100·175

* Edinb. N. Phil. Jour., No. XIX, p. 35.
† Outlines of Mineral. Geol. and Min. Anal., vol. i, p. 348.

It is strange that in Thomson's Outlines of Min., Geol., &c., the analysis of Connell is given with altogethor different figures—thus:

Silica,	52·400
Alumina,	15·918
Baryta,	5·827
Strontia,	7·709
Lime,	1·007
Water,	·208
Peroxyd iron,	12·584
	95·653

Dr. Thomson remarking at the bottom of the page that the specimen analyzed by himself consisted of fine crystals carefully selected, while that examined by Mr. Connell was a mixture of amorphous and crystallized mineral.

The method for the separation of baryta, strontia, and lime, employed by Connell—probably by both analysts—namely, the solution of nitrate of lime and afterwards of chlorid of strontium, in alcohol—has given place to more reliable processes, and on this account a repetition of the analysis might be desirable; but it becomes still more so when the close analogy of brewsterite to heulandite is considered. The two species should in all probability have the same general formula, and this has in fact been assigned to them in Dana's Mineralogy, but with the formula for heulandite these older analyses of brewsterite do not very well agree.

I have recently analyzed some fine specimens, from the original locality—Strontian in Argyleshire, Scotland—and the results appear fully to establish the chemical as well as crystallographic relationship with heulandite.

The mineral formed crusts of minute crystals upon the surface of gneiss: sometimes these crusts could be detached from the rock by careful blows, but in general they adhered very firmly. Some of the crystals were an eighth of an inch in length—most of them were much smaller. The following measurements were obtained—using the lettering of Dana.

$O : \frac{1}{5}\text{-}\bar{\imath} = 175° 49'—175° 58'—175° 55'$

$\frac{1}{5}\text{-}\bar{\imath} : \frac{1}{5}\text{-}\bar{\imath} = 171° 43'—171° 40'.$

$I : I = 136° 13'.$

$O : 1\text{-}\bar{\imath}\ (?) = 157° 28'—157° 17'—157° 20'—157° 22'.$

$I : i\text{-}\bar{\imath} = 112° 13'—112° 17'—112° 12'.$

The spec. grav. was found = 2·453.

For analysis the crystals were carefully broken off, and picked clean from any dust of the accompanying rock. In one case, the mineral was fluxed with carbonate of soda, so as to ensure perfect decomposition, and consequent purity of the silicic acid

weighed; the other specimens were treated directly with hydrochloric acid, which seems of itself to be capable of effecting complete decomposition. The baryta was precipitated by hydrofluosilicic acid,* and the relative amounts of lime and strontia were determined indirectly, by weighing the mixed earths first as sulphates and then as carbonates.

The following are the results obtained—

	(1)	(2)	(3)	(4)	(5)	Mean.		Atoms.
Silica,	54·49	53·66	54·31	54·34	....	54·42	1·209	4·08
Alumina,	15·42	15·29	15·05	....	....	15·25	·296	1·
Peroxyd of iron,	*trace*	·08	*trace*	....	....	....	....	
Baryta,	6·76	6·84	....	....	....	6·80	·089	·304—1·03
Strontia,	8·79	9·20	....	....	....	8·99	·173	
Lime,	·92	1·46	....	....	....	1·19	·042	
Water,	13·39	....	....	....	13·06	13·22	1·469	4·96
	99·67					99·87		

Analysis (4) was spoiled by an accident; and in (3) the determination of the earths was abandoned on ascertaining the necessity for the removal of ammoniacal salts before precipitating baryta (vid. note), a precaution which had not been taken in this case.

The silicic acid, alumina, protoxyds and water are clearly present in the ratio 4 : 1 : 1 : 5, giving the formula

$$(BaO, SrO, CaO), SiO_3 + Al_2O_3, 3SiO_3 + 5HO.$$

The atomic relation between the lime, baryta and strontia is near 1 : 2 : 4.

* In examining the precautions incident to this mode of determining baryta in the presence of strontia or lime, I have found no notice taken in any work on chemical analysis of the solvent effect of ammoniacal salts upon silico-fluorid of barium.

Fresenius states that the latter dissolves in 3400 to 3800 parts of water, and in 640 to 733 parts of water acidified by hydrochloric acid, but does not mention salts of ammonia.

I digested pure silico-fluorid of barium in the cold, with frequent stirring, for forty-eight hours—(*a*) with a saturated solution of chlorid of ammonium, (*b*) with the same solution diluted with twice its volume of water. The fluid was in each case filtered off perfectly clear, 100 cubic centimetres were measured, and the baryta was determined as sulphate.

(*a*) gave ·1942 grm. of $BaO, SO_3 =$ ·2338 grm. of BaF, SiF_2. Hence 1 part of the latter salt dissolves in 428 parts of a saturated solution of sal-ammoniac.

(*b*) gave ·1409 grm. of $BaO, SO_3 =$ ·1697 grm. of BaF, SiF_2, or 1 part in 589 of the diluted solution.

The necessity of removing ammoniacal salts from a fluid in which baryta is to be determined as silico-fluorid is sufficiently obvious.

ART. VI.—*On the importance of more frequent and more accurate Deep-sea Soundings in connection with the successful establishment of a Submarine Telegraph across the Atlantic;* by Prof. W. P. TROWBRIDGE, Assistant U. S. Coast Survey.

IN the year 1849, two citizens of Philadelphia, Horatio Hubbell, Esq., and Col. John H. Sherbourne, presented a lengthy memorial to Congress promulgating a plan for establishing telegraphic communication across the Atlantic ocean; and asking the Government to aid in carrying out the project. This memorial contained the announcement of the probable existence of a table-land or plateau between Newfoundland and Ireland, in the following words.

"Your memorialists proceed to say that from many observations which have been made, there is incontestible evidence of the existence of a submarine table land extending from the banks of Newfoundland across the Atlantic ocean to the mouth of the British Channel." "This is proved by the altered color of the sea water, which has a different appearance, in unfathomable places, from what it has in shallow spots." "This combined with the volcanic construction of Iceland and the Azores, and the situation of that portion of the ocean that lies between these volcanic groups, has led to the conclusion that there has been a lifting up of the bottom of the sea, through the agency of a Plutonic power, and that the bottom thus elevated appears to be cut through, in many places, by deep-water channels." "The appearance of Medusæ, Polypi, and other marine creations, seen upon the edge of the discolored water, strengthens this opinion." "Your memorialists propose that these suggestions should be investigated," &c.

The first experiments made to test the truth of these suggestions were the soundings of Commander Berryman, made in the summer of 1853. Previous to this time no cast of the deep-sea lead had ever been made north of the Azores. The soundings of Berryman, and the subsequent soundings of Commander Dayman, have been variously interpreted concerning the proof of the existence of the submarine table-land announced by Messrs. Hubbell and Sherbourne. In a popular sense this announcement conveyed the idea of a vast unbroken level at the bottom of the sea, the existence of which has not been conclusively established by the soundings referred to.

The question, however, is one of very little importance, provided the irregularities of the bottom do not offer any serious obstacle to the safe descent of an electric cable, or cause its destruction subsequently. The question now presented is, taking the bottom of the ocean as it probably exists, with elevations and

depressions corresponding to those found upon the face of the dry land, what influence will these elevations have upon the practical operation of depositing an electric cable, and in the preservation of the electric continuity. Upon this point there has been very little discussion, on account of the popular belief in the existence of a level bottom across the only part of the ocean where a submarine telegraph has been supposed to be practicable. But even upon the line of the Atlantic telegraph, although there may not exist remarkable submarine mountains and valleys, yet it is not improbable that considerable elevations and depressions occur. The profile of Capt. Dayman differed essentially from that of Commander Berryman; so much so as to give rise to serious controversies with regard to the strict correctness of both, since to the probable uncertainties of the soundings, was added the uncertainties in relation to the intermediate depths, the soundings being made generally fifty to one hundred miles apart.

The explorations of Dayman and Berryman ought therefore to be regarded as general reconnoissances only, from which the true profile of the bottom can only be conjectured. In the explorations of the Gulf Stream by the U. S. Coast Survey, Lieutenants Craven and Maffitt discovered, off Charleston, a series of submarine ridges and depressions several hundred fathoms in height and depth in the horizontal distance of twenty to thirty miles. Such ridges and valleys would have been passed unnoticed in the explorations between Newfoundland and Ireland.

It may be taken for granted that a submarine cable should touch the bottom at every point; otherwise some parts of it must remain suspended across valleys, or chasms, of unknown depth and extent; under these circumstances its continuity is endangered by its weight, its chafing at the points of suspension, the action of currents, and other causes. Whether the Atlantic cable was destroyed by such influences or not will probably never be revealed, but it may be important to examine how far a more accurate and detailed section of the bottom may diminish the risks which must always attend an enterprise of this character.

Such ridges and elevations as were found in the Gulf Stream, though moderate in height and depth when compared with the great depths of the Atlantic, are yet of sufficient magnitude to be taken into account.

The facility with which the ocean is traversed upon its level surface, and its great horizontal extent, compared with its depth, are apt to give rise to inadequate conceptions of the real magnitude of the inequalities of the bottom,—inequalities which upon dry land would be overcome with difficulty. But when it

is intended to adapt a line to these inequalities, it is their real and not their comparative magnitudes which must be taken into account.

An accurate and detailed profile of the bottom is therefore necessary in order to estimate correctly the total amount of cable required to reach from one point to another, following the curve of the bottom, This is importont, not only in determining the total depth of cable necessary to reach from continent to continent, but also to shew at what points a greater or less surplus over the horizontal extent is needed.

It is only by the aid of accurate knowledge upon these points that the practical operation of depositing a cable can be reduced to a positive degree of safety and certainty. It was shown in a paper communicated to the American Association for the Advancement of Science at the Baltimore meeting, April, 1858, that in laying a submarine cable, *if the rate of paying out be equal to the speed of the ship, and if the speed of the ship be greater than the rate of descent of the cable in the water, the form assumed by the cable from the ship to the bottom will be a right line*, and there will be no tension upon the cable, *provided* the bottom be a uniform level plain. But if, from depositing upon a level bottom, a descending slope be reached, the cable from the ship to the bottom will form a large catenary, one end of the catenary being at the ship and the other at the crest of the descending slope.

The catenary will produce a dangerous tension upon the cable, if the descent of the slope at the bottom be very deep, unless the speed of the ship be slackened.

The failure of the first attempt to lay the Atlantic cable off the coast of Ireland was doubtless due to this cause. The bottom suddenly fell off from five hundred fathoms to seventeen hundred fathoms, a descent of seven thousand feet, and the same speed being kept up, with nearly the same rate of delivery, it was impossible for the cable to assume the form of the bottom, and a catenary of large dimensions must have been formed, causing the great tension which parted the cable. The same circumstances must occur on a smaller scale when the depression is more moderate, even in deep water: and it may happen that a submarine valley is passed before the cable has had time to descend to the crests; in which case, if the surplus paid out between the crests be insufficient, there must inevitably be a catenary formed from one crest to the other, the effect of which cannot be avoided or foreseen.

It may therefore be safely asserted, that to avoid risk of breaking a cable in the operation of depositing it upon the bottom of the sea, *the speed of the ship should be regulated by the depth and form of the bottom.* If the principle be adopted of paying out a uniform surplus to suit all the inequalities of the bottom, there

will not only be an unnecessary waste of cable in some places, but the surplus may fail to be sufficient in others, the result of which might be a rupture.

On the other hand, provided an accurate and detailed profile of the bottom be constructed, from which the exact length of cable required between any two points, however near together, can be determined, there is no reason why an irregular form of bottom should present any serious obstacle to the safe deposit of a cable, provided the speed of the ship be so regulated as to deposit the proper amount in the proper place; and it is only by following this rule that risk of breaking from the weight of the cable can be avoided.

In conclusion, the following rules may be stated.

1. Soundings of unquestionable accuracy should be made at intervals not greater than ten miles, and where there is a steep slope of the bottom, at more frequent intervals.

2. From these soundings a profile of the bottom should be made, in sections, upon a large scale, from which the length of the curve of the bottom may be calculated.

3. A chart should be constructed based upon the profile, showing the rate of speed and delivery between the different stations, in order that the cable paid out may adapt itself without tension to the curve of the bottom.

4. The profile and chart should be used as guides in the operation of laying the cable.

There is a popular belief that many parts of the Atlantic across which submarine lines of telegraph have been projected, are filled with mountains and valleys of vast magnitude. All that can be said on this subject is, that the reported measurements of great depths are neither sufficiently accurate or numerous to lead to any probable conjecture of the natural features of the bottom. And the needle-like elevations which have been represented to exist, are more the result of imagination than a representation of facts. Whatever the form of the bottom may be, an accurate profile of it is the only true basis upon which any reliable calculations with regard to the practicability of a submarine telegraph can be made.

And with the help of such accurate profiles even where great irregularities of bottom exist, the risks of failure may not be so great as has generally been supposed. And it is not improbable that the Azores might be made an intermediate station between the two continents notwithstanding the supposed rugged character of the bottom near them; while there is yet no *proof* that the bottom between the Azores and the Banks of Newfoundland is at all unfavorable to such a project.

Art. VII.—*Abstract of a paper on the Ophiurans, a tribe of Starfishes;* by Dr. Chr. F. Lütken.*

Terminology and Morphology.

The body of an Ophiuran consists of a disc, and five or six† arms issuing therefrom. The disc contains the digestive and reproductive organs and their outward openings, namely: the mouth with its five slits (*rimae oris*) forming a star in the centre, and twenty (in *Ophioderma*, &c.) or ten (in *Ophiocoma*, &c.) genital slits, on the under surface, parallel with and close to the arms. The arms have a solid frame and are supplied with nerves, vessels and muscles, and, by reason of their length and flexibility, acquire, as organs of motions, a perfection quite wanting among the true sea-stars. On its upper surface the disc generally presents an unbroken edge, but below it is invaded by the arms, which pass along its under surface, quite to the mouth-slits. In describing Ophiuræ the mouth is placed *downwards*, the back of the disc is therefore the *upper* surface, towards the periphery is *outward*, towards the centre *inward*. The solid parts belong to three different systems, the *interior skeleton*, the *skin skeleton* and the *surface skeleton*. This is the arrangement of Gaudry,‡ though his interpretations are not always right, as will presently be seen. The interior skeleton is nothing more than the ambulacral plates turned upwards and inwards, soldered by their sides in pairs and enclosed by the interambulacral plates. It consists of a series of discoid joints (*ossicula ambulacralia—ossicules discoides*, Gaudry—*Ambulacralwirbel*, Joh. Müller,) which follow each other, like vertebræ, and are connected, partly by a sort of hinge, and partly by muscular bands extending from joint to joint. Each joint has an incision above and below, indicating the line of juncture of the two halves of which it is made up. The outer end of each joint carries a part of the hinge, consisting of three teeth, whereof the lowest runs upwards and is embraced by the two uppermost; on the inner end of the following joint is fixed the corresponding part of the hinge, namely, two edges diverging from each other below, but joined above. On the lower side is a conical cavity for the root of the tentacle.

This is the structure among the typical Ophiurans; but two points, mentioned by Gaudry in *Asterophyton*, deserve notice. The first is, that, when the arm divides in two equal branches,

* Additamenta ad historiam Ophiudarum. Af det Kgl. danske Videnskabernes Selskabs Skrifter. 5te Række 5te Bind. For this Abstract the Journal is indebted to Theodore Lyman of Boston.

† In certain species of the genus *Ophiactis* (Lütken) and in *Ophiocoma pumella* (Lüt.).

‡ Annales des Sciences Naturelles, 3me Serie Zoöl. xvi, 339.

the joint, just before the fork, has two discs, instead of one; when on the contrary a small branch is given off from the leading stem, the joints of the small branch may be traced between the joints and the skin of the stem until they become mere grains, and so disappear. And secondly, the roots of the tentacles are, in *Asterophyton*, fixed between the joints, while among the Ophiuræ they are received in a conical hole in the joint itself. The two innermost joints are the only ones which deviate much from the form already described. These are modified to form the jaw apparatus. The component halves of the last joint but one, though still remaining united, bend to the right and left, in the direction of the corresponding pieces of the neighboring arms on either side; but the halves of the innermost joint of all are completely sundered, and, inclining to the right and left, are soldered to the corresponding pieces of the neighboring arms on either side. It is these latter pieces that give the outline to the five triangular projections, which bear all the chewing apparatus (*Mundeckstücke*, Müller; *scutella oralia* or *mouth-frames*). These mouth-frames, on their sides, may be beset with mouth-papillæ. To their inner point is attached a vertical plate, the "jaw" (*maxilla, torus angularis*, Müller), and this bears the teeth (*dentes*) and the tooth-papillæ (*papillæ dentales*). Müller, in the "System der Asteriden" uses the word "*maxiller*" at random for mouth-frames and jaws. These parts are commonly visible on the outside, but, in Ophioderma and allied genera, they are covered with grains. All the rest of the interior skeleton is hidden by the skin-skeleton. Müller and Troschel, in the same work, point out the homology between the discs in the arms of the Ophiuræ and the joints in those of star-fishes; but as they started with the idea that these joints constituted a true internal skeleton, they came to the opinion that this was peculiar, and not to be found in any other Echinodermata. Gaudry, also, does not consider the interior skeleton of Ophiurans as homologous with ambulacral plates, but looks on it as a special structure in serpent-stars. It is in the side arm-plates that he finds the homologues of the ambulacra.

The *skin-skeleton* proper is to be found in the scales on the disc, the genital plates and the four rows of plates on the arms called upper, under and side plates (*scutella dorsalia, ventralia, lateralia*). To the jointed structure of the interior arm-skeleton corresponds, consequently, a similar one in the skin-skeleton. An upper, an under, and two side plates together form a joint, and this corresponds to a joint of the interior skeleton, except that the plates extend beyond their proper joint to the next outer joint. The four plates sometimes lie side by side, but again the side plates may alternate with the others, particularly when the former are little developed. As to their form, the upper plates,

as a general rule, occupy the whole upper surface of the arm, but the under plates may be square or eight-sided, and are often cut out on the sides to give room for the tentacle scales. The innermost under plate varies in shape, and is often very small. At the extremity of the arm the joints are proportionately longer and are contracted at their bases; the upper and under plates become smaller and are supplanted by the side plates, which meet on the middle lines above and below, and at last constitute almost the whole covering of the tip joints. Therefore, the shape of the plates, exposed as it is to constant changes, should always be referred to the portions of the arm close to the disc. These modifications appear sooner in species with short and quickly tapering arms, than in those with longer and more slender ones. There are, however, many serpent-stars, the inner plates of whose arms present features usually seen only at the extremities (e. g. *Ophiura*). The upper plates are sometimes divided in pieces by transverse lines; (compare species of *Ophioderma*, and *Ophiolepis imbricata*, *O. triloba*, *O. Nereis*, *O. Januarii*). *Ophiomyxa* and *Ophioscolex* are supposed to have the skin skeleton replaced by a soft dermal envelop, but there may still be seen traces of arm plates; at least in *Ophiomyxa*. The whole group of Euryalæ has the skin-skeleton either quite wanting or very rudimentary; but, to balance this, the exterior skeleton is highly developed. According to Gaudry, the four rows of little bony pieces on the under side of the arm and under the skin, among Euryalæ, correspond to the arm-plates. Along each genital opening, between it and the arm, and not visible from the outside, runs a narrow, sloping piece, the genital plate (*scutum genitale*). Its narrow end is turned inward and sometime touches a terminal piece, running from the lateral mouth-shield upwards. The outside end of the genital plate is joined with a smaller supplementary piece, which extends vertically upwards and unites again with the radial shields, at a point near the edge of the disc. These parts are never wanting: they are present, even when all other portions of the skin-skeleton have disappeared. Among the various plates and shields covering the disc are reckoned, first: the mouth-shields (*scuta oralia*), five in number, ranged in a circle about the mouth and placed in the interbrachial spaces, just outside the mouth-frames. One of these may bear the madreporic body, and is then usually somewhat different from its companions in shape. The madreporic body appears as a slight depression or elevation on the surface and communicates beneath with the "stone-canal." Along the edge of the madreporic mouth-shield there are sometimes pores.* Secondly: the lateral mouth-shields (*scutella adoralia*), which are just inside

* See J. Müller: Über die Gattungen der Seeigellarven, 1833, page 33, and Le Conte, Proc. Phil. Acad. v, p. 317, 18.

the mouth-shields and vary considerably in shape, position and size. They are arranged in pairs, a pair to each mouth-shield. Thirdly: on the back of the disc, and placed over the base of each arm, are five pairs of radial shields (*scutella radialia*), very conspicuous, when not covered by skin, spines or the like, for their peculiar form, regular position, and greater size. Fourthly: the other parts of the surface of the disc may be covered with scales, of a great variety of shapes and sizes, but usually small and rounded.* Among these scales may be pointed out two which are sometimes found (e. g. *Ophiothrix*). They start from the outer edge of the mouth-shield and run along each edge of the genital opening.

Sometimes the skin-skeleton, on the disc, is naked, (some species of *Ophiolepis* Müll. and Trosch.), but generally it is covered by a tegument of grains, or short spines (*Ophioderma*, *Ophiarachna*, *Ophiopeza, Ophiocoma*, *Ophiostigma*, *Ophiacantha*) granular plates and spines (*Ophiopholis*) or thorny spines (*Ophiothrix*). This tegument, together with the teeth, teeth-papillæ, mouth-papillæ, tentacle-scales and arm-spines, constitutes the *surface-skeleton.* Among the Euryalæ this covering is highly developed, and in some sort takes the place of the true skin-skeleton. On the outer parts of the arms and sometimes over the whole body, the rows of grains are armed with hooks. The lower edges of the mouth-slits may be ornamented with mouth-papillæ, which vary in size, shape and number, they may be entirely wanting (in *Ophiothrix*); in *Ophiomyxa* they take the form of lobes, beset with fine points, *Ophiactis* has but one or two on each side of the mouth-frames, *Amphiura* three, while *Ophioderma* may attain even to ten. The teeth proper are plates, arranged in a vertical row along the jaw; and the teeth-papillæ are only grains or short spines which may replace a part or the whole of the teeth; (compare *Ophiocoma* and *Ophiothrix*). It is in *Asterophyton* that the perfect homology of these variable organs is distinctly shown; in this genus all the chewing apparatus takes on the form of sharp spines. Along the underside of the arm runs a double row of pores, from which the tentacles protrude, and, on the inner side of each pore, one, two, or even four scales or papillæ (*papillae ambulacrales*) are placed, which serve to cover the tentacle when it is drawn in. They may, however, be entirely wanting (in *Ophiomyxa* and *Ophiothrix*). When there are more than one on the basal pores of the arm, they decrease in number towards the tip. At the outer end of each mouth-slit are two tentacles (*pedes orales*) which are the last pair at the base of the arm. These, according to Forbes, are used to remove the undi-

* For further remarks on the Ophiuran Skeleton, see J. Müller: Über die Ophiurenlarven des Adriatischen Meeres, 1851, p. 1, and, Über den Bau der Echinodermen, 1853, p. 51 and 76.

gested food from the mouth. The side plates of the arm carry the arm-spines (*spinae laterales vel brachiales*). These are arranged in sets, and, at the pleasure of the animal, may be raised from the arm, depressed, with their points outward, and spread and closed like a fan. They are placed either along the outside border of the plate, in which case they are small and usually pressed close to the arm; or else on a little ridge in the middle of the plate, and then their length is greater and their normal position at right angles with the length of the arm. They are never entirely wanting, but vary, in number from two to ten; in length, from one half (*Ophiura nodosa*, &c.) to six times (*Ophiothrix*) the length of a joint; and in form, from the small, smooth, tooth-like papilla of *Ophioderma* to the long glossy, thorned spine of *Ophiothrix*. As to their arrangement in the vertical rows, they are either all of the same length, or they decrease from lowest to highest and *vice versa*, or, finally, from one of the middle ones towards each end of the row. When they are rough and pointed, the lowest one, at least in the young animals and on the outer joints of the old, is commonly changed to a little hook. A striking instance is not wanting to show the strict homology between the spines and tentacle scales, for, on the innermost joint of *Ophiura texturata* these parts are so alike, that they cannot be distinguished. Towards the tips of the arm the spines diminish in number but increase in proportionate length.

Growth of Ophiurans.

The variations which the Ophiuran is subject to, from the time it leaves the egg till the serpent-star emerges from the larval condition, are explained in Joh. Müller's most admirable investigations of the metamorphoses of the Echinodermata. In regard to the variations it undergoes, after the metamorphosis has taken place, we know little or nothing, except that these variations are not unimportant. The serpent-star does not appear completely finished on emerging from its larval form; when newly born and rambling about on the surface of the water, it is not more like the full grown animal, than a young opossum is like its parents. We may see perhaps, that they belong to one or the other of the Ophiuran series, but, as to the species, we can only guess at it from the locality or abundance of the specimens. Even in the half grown animal there are still such variations from the adult form that the identity might be doubted were not the intermediate steps known. It is therefore plain, that the description of a species is not full, until several ages of that species have been properly illustrated. The following table will show approximately some changes which take place during the growth of *Ophiopholis aculeata* (*Ophiolepis scolopendrica*). The diameter of the disc, the length of the arms, the number of joints

in the arms, the number of joints with hooks on the under side and the number of joints without a circle of grains round the upper arm-plate are brought into immediate comparison.

Diameter of disc.	Length of arm.	No. of joints.	Joints with hooks.	Joints without circle of grains.
2 mm.	6 mm.	20	15	12
3		40	27	
4		45–50	33	20
6	33	63		
10	60	86		
14	72	105	40–50	18

According to this table both the disc and the arms continue to grow, but the latter the faster. During the growth of the arms new joints are formed, and this increase of joints seems greatest in the very young animal. The new joints appear at the tip of the arm and not at the base, next the mouth.

Subdivisions of genus Ophiolepis (Müll. & Trosch.).

This genus is thus described by its authors: "Naked scales, or little shields, on the disc. Mouth-slits surrounded by a single row of hard papillæ, without an increase of their number over the tooth-columns." It will presently appear, however, that the species included under this definition represent several genera. Following the suggestions of Forbes, it will be seen, that *Ophiolepis* includes two series of scaly Ophiurans, one answering in some sort to the type of *Ophioderma*, the other to that of *Ophiocoma*, as expressed in the following table.

First Series—Type of *Ophioderma.*

Mouth-shields lyre- or shield-shaped extending outwards into the interbrachial spaces, so as to separate the inner ends of the genital opening. At the base of the arms, incisions in the dorsal side of the disc. Arm-spines more or less closely pressed to the sides of the arm, and arranged along the outer edge of the side arm-plates.

Ophiura.—Disc covered with larger or smaller scales, smooth and naked radial shields tolerably large, protruding, more or less distinct. Incision in the disc limited by two arches curving outwards, and admitting three to four imperfect upper arm-plates; on its edges a close crest of from ten to thirty papillæ, which are continued underneath, along the edge of the genital opening, to the mouth-shield. Another more obscure crest of papillæ lying under the first and running only a short distance. Mouth-shields very large, generally longer than broad, shield-shaped, extending into the interbrachial spaces, thus separating the inner ends of the genital opening: the madreporic shields not differing in form. Side mouth-shields narrow, lying inside the mouth-shields prop-

er; joined at apex; their outer ends separating the mouth-shield from the innermost arm-plate. Teeth narrow, pointed, shaped like a spear-head. Mouth-tentacles coming from slits which lie just within the innermost arm-plate, and which open obliquely into the mouth-slits giving them the appearance of a Y. These slits for the tentacles are surrounded with from four to eight papillæ. Arms conical and pointed; short or of moderate length. Upper arm-plates somewhat broad. Lower arm-plates seldom touching each other, by reason of the side arm-plates which lap over and meet on the middle line of the arm. Tentacle-scales one to four. Spines short and smooth, generally arranged in three rows, on the outer edge of the side arm-plate, and pressed close to the arm. Mouth-frames furnished with mouth-papillæ. Species: *O. affinis*, *O. carnea*, *O. Stuwitzii*, *O. nodosa*, *O. squamosa*, *O. albida*, *O. Sarsii*, *O. Wetherelli* (London clay), two species from the chalk, and *O. abyssicola*, which may be an *Ophiocten*. This genus is essentially of the cold sea-belt, north of 30° North Lat.

Ophiocten.—Disc invested with scales, which are covered with flat grains and larger or smaller round spots. Incision, in disc above arms, slight, not deep enough to receive an upper arm-plate; on its edge a continuous comb of papillæ. Openings for the mouth-tentacles as in Ophiura, but not opening into the mouth-slits. Outer edges of first two or three upper arm-plates beset with papillæ. One tentacle-scale. Radial shields, mouth-shields, side mouth-shields, teeth, arms, lower arm-plates, arm-spines, and mouth-papillæ as in Ophiura. Species: *Ophiocten Kröyeri.*

Ophiolepis.—Mouth-shields small and narrow. No papillæ round the incision in the disc. Innermost tentacle-pores not placed close to mouth-slits. Dorsal scales surrounded by semicircles of small scales. Two tentacle-scales, which are placed obliquely side by side. As this group is put foremost in "System der Asteriden," the name *Ophiolepis* should be reserved for it. It is limited to the hot zone and embraces *O. annulosa*, *O. cincta*, *O. variegata* (Lüt.), *O. pacifica* (Lüt.), *O. paucispina* (Say), an undescribed West-Indian species and two new species from the west coast of America.

SECOND SERIES—Type of *Ophiocoma.**

Mouth-shields small and rounded, not extending outwards into the interbrachial spaces, so that the inner ends of the genital

* Dr. Lütken gives only a sketch of the genera belonging to the second series, as he intends to publish another part of the same work, wherein he will speak of them at greater length. The following are among the new Ophiurans described, or to be described, in the two papers: *Ophiura carnea* (Sars, Ms.) *Ophiura Sarsii* (Lütken), *Ophiura affinis* (Lüt.), *Ophiura squamosa* (Lüt.), *Ophiura nodosa* (Lüt.), *Ophiura Stuwitzii* (Lüt.), *Ophiocten Kröyeri* (Lüt.), *Ophiolepis variegata* (Lüt.), *Ophiolepis pacifica* (Lüt.), and another not yet named: *O. Januarii*, *O. triloba* and *O. Nereis.*

opening approach close to each other, on the outer side of the mouth-shield. Arm-spines mounted on a raised keel, and standing boldly out from the arm. Upper edge of the disc, at the base of the arms, entire and without incision.

Genus 1. Mouth-shields small, rounded, with a small, outward projection, separating the inner ends of the genital opening. On the back of the disc, traces of an incision at the base of each arm. Disc covered with moderate scales. Radial shields not large. Lateral mouth-shields within the mouth-shields proper. Below the teeth, two broad, flat, tooth-papillæ. Upper arm-plates divided in two. Two tentacle-scales. Three to four arm-spines. Species *O. Januarii.*

Genus 2. Arms very long and thin. Disc with very small scales, of which some, near the edge, a little larger. Radial shields very small. Lateral mouth-shields on each side of the mouth-shields proper. Upper arm-plates divided in three. One tentacle-scale. Three short arm-spines. Species: *O. reticulata, O. triloba, O. Nereis.*

Genus 3. Scales of the disc and radial shields rather small. No larger scales near edge of disc. Lateral mouth-shields within mouth-shields proper. Two tentacle-scales. Upper arm-plates covered with many small scales. Species *O. imbricata.*

Genus 4. *Amphiura.*—Disc with small, numerous scales, arranged like tiles. Radial shields very distinct. An inward curve of the disc, at the base of the arms, above. Mouth-shields small, not extending into the interbrachial spaces. Side mouth-shields within the mouth-shields. Teeth broad, quadrangular. Arms extremely long and slender. Upper arm-plates oval. Lower arm-plates quadrangular or five-sided. One, two, or no tentacle scales. Spines feeble, on a slight keel. Disc small. Six mouth-papillæ, sometimes the middle ones moved out, so as to cover the basal ones. Species *A. Chiajei, A. Holbölli, A. Orstedii, A. marginata, A. squamata,* &c.

Genus 5. *Ophiopholis.*—Disc with small and numerous scales, covered below by short spines, above by short spines and grains and by plates arranged in ten radiating rows. Radial shields covered. No incision in back of disc. Mouth-shields small, not extending into interbrachial spaces. Side mouth-shields within the mouth-shields. Teeth very broad. Arms long and thick. Upper arm-plates surrounded by small scales. Lower arm-plates square. One foot-papilla. Arm-spines close set, the lower ones, at the tip of the arm, in form of double hooks. Mouth-papillæ six to each jaw, but none under the teeth. Side arm-plates like little keels. Species *O. aculeata.*

Genus 6. *Ophiactis.*—Disc nearly as in Amphiura, but on some of the scales are a few small spines. Arms five or six, rather short and thick. Teeth broad. One or two mouth-papillæ to

each mouth-frame. Side mouth-shields wedged between first and second lower arm-plate, so as to form almost a ring round the mouth. One tentacle-scale. Three to six rough arm-spines. Seven species.

NEW OR LITTLE KNOWN SPECIES.

Ophiura carnea (Sars, Ms.).—Lütken, p. 41. Tab. I, fig. 6.

Arms rather short. Disc thick, covered above with large, rounded, angular scales. Radial shields shaped like a short, thick pear seed, inconspicuous, separated nearly by a round scale. Incision in the disc with margins almost perpendicular, with a row of twelve broad and flat papillæ on each side, which are continued by fine grains along the genital openings. Two small, perpendicular plates, side by side in each incision of the disc, with a row of papillæ on either side. Length of mouth-shields greater than breadth, and than distance from margin of disc. Under arm-plates like segments of a circle, separated from each other, without exception, by the overlapping side arm-plates. Upper arm-plates in contact at the base of the arm, but, farther out, separated by the overlapping of the side arm-plates. Three thin, weak arm-spines. One tentacle-scale. Diameter of disc 6 mm.; arms at least double that length. Color of upper surface a fine rose. Stands nearest to O. albida, from which it differs by having a thicker disc, arms shorter and broader, the innermost upper arm-plate divided in two, mouth-shields longer, and more of the upper arm-plates separated from each other. County of Bergen, 60 to 80 fathoms; Kongeströmmen, 50 fathoms; Biskopshavnen and Manger, 50 to 60 fathoms.

Ophiura Sarsii (Lütken).—Lütken, p. 42, Tab. I, figs. 3, 4.

Ophiolepis ciliata? (Stimpson, Invert. of Grand Manan, Smithson. Contrib.).
Ophiolepis ciliata, (Sars Travels in Lofoten and Finmarken).
Ophiura coriacea? (Lütken, Preliminary Rev.; from Scien. Com. Soc. Nat. Hist.).
Ophiura arctica? (Lütken, " " " " " " " ").
Ophiura glacialis? (Young?), (Forbes).

Scale tegument varying somewhat as in allied species. Radial shields shaped like a pear seed, the small end inwards; their length to the diameter of the disc as 1 : 5 or 1 : 6 and to their breadth as 4 : 3. The rest of the scales uniform, but sometimes there is, in the middle of the back, a larger one, with rows, also of larger scales, radiating from it. Scales of under surface growing smaller towards mouth-shields. Incisions in the back of disc very deep, so as to receive four upper arm-plates; on either side a comb of ten to fifteen papillæ, of which the uppermost are on the edge of the radial shields. Outside this comb and often hidden by it, a row of small grains and a similar one along the genital opening. Mouth-shields about as in O. texturata; their length to breadth as 7 : 5. Side mouth-shields narrow and of uniform breadth at the two ends. On each side of the innermost tentacle-pores from five to six papillæ, and between these and the mouth, four to six mouth-papillæ. Upper arm-plates, at base of arms, four or five times as broad as long, but, at the tip, longer than broad. Lower arm-plate, at base of arms, twice as broad as long further out, almost disappearing. Two tentacle-scales generally, but sometimes three, or again only one. Three arm-spines, of which the lowest and shortest is not so long as the side arm-plate; the longest, at the tip of the arm, are as long as the side arm-plates; but, at the base of the arm, double that length. Color, mixed, of green, yellow and gray; sometimes light stripes on arms. The disc attains a diameter of 27 mm.; and the arms a length of 100 mm. Is distinguished from O. texturata by the different number of tentacle-scales, the different form of papillæ at incision in disc, the different shape of lower arm-plates and by wanting the pores at the base of the under surface of the arm. Young, with diameter of 4 to 6 mm., have incisions of disc less deep, fewer and proportionately larger dorsal scales, radial-shields shorter and closer together, upper arm-plates narrower, and often only one tentacle scale. These young resemble, therefore, the full grown *O. albida*. On the whole coast of Greenland, 8 to 60 fathoms, and further south at Tromsöe, also at Spitsbergen, at Floröe and Storsund in Norway, and undoubtedly at Grand Manan Is. (Stimpson loc. cit. *Ophiolepis ciliata*).

Ophiura affinis (Lütken).—Lütken, p. 45, Tab. II, fig. 10.

On the back of the disc a central large scale and fifteen others, arranged in concentric circles round it; between all these are smaller scales. Radial shields short, broad, separated by a wedge of small scales. Mouth-shields much as in *O. Sarsii*. Disc incisions with seven to nine papillæ on each side, which are strongest above. Behind these are secondary papillæ. No papillæ on the genital openings. Upper arm-plates, at the base of arm, touching each other; farther out, longer and narrower. Three thin arm-spines, the two longest equal, and as long as side arm-plates. Only one tentacle-scale. Even the innermost under arm-plates separated by side arm-plates overlapping; and they become, a little way from the disc, semicircular and almost rudimentary, being not larger than a tentacle-scale. Color bright, almost pink, with a variety of stripes on disc and of belts on arms. Diameter of disc 5 to 6 mm. and the length of arms about thrice as many. Bollaerene, Asgaardstrand, 20 to 30 fathoms. Hellebæk, 10 to 18 fathoms. This is the smallest serpent-star of North Europe and, as its name suggests, has more affinity with *Ophiocten* than the other Ophiurae.

Ophiura squamosa (Lütken).—Lütken, p. 46, Tab. I, fig. 7.

(An *O. fasciculata* [Forbes]? Sutherland's Journal of Journey, &c.)

Disc with flat, uniform scales, above rounded, below more oval. Radial shields short, thick, not conspicuous. Incisions of disc bordered by a double row of stout, equally developed papillæ. Genital openings bordered by grains. Mouth-shields small, of a regular shield-shape, as broad as, or broader than long. Side mouth-shields long, narrow, of equal breadth. On each side of the innermost tentacle-pores four or five large, round papillae. Arms thin, rather long. Upper arm-plates broad hexagonal, nearly as in *O. albida* and in young of *O. Sarsii*. Under arm-plates narrow, heart-shaped, the point inwards. One tentacle-scale. The upper arm-spine as long as a joint, and, in large specimens from Greenland, often thickened and somewhat flat; under arm-spine only about half as long. In specimens from Greenland diameter of disc as great as 10 mm.; length of arms 30 mm.; in those from the Sound, disc 7 mm., arms 21 mm.. Color; disc, above dark gray, below, ash gray; arms, green gray with darker bands. Sometimes the color is reddish, or violet, or spotted red and gray. Generally the radial shields make two bright marks, and there is a violet spot on each mouth-shield. Hellebæk, 10 to 18 fathoms; Greenland; Taarbaek; Faröe Is.; Tromsöe; Stötö; Florö; Newfoundland. Young, with a disc of 3½ mm., have thin arms and upper arm-plates very narrow.

Ophiura nodosa (Lütken).—Lütken, p. 48, Tab. II, fig. 9.

This species and *O. Stuwitzii* stand as a separate group under the genus *Ophiura*. They are characterized by the short, stout, knotted arms, numerous tentacle-scales, very small arm-spines, and by the peculiar forms of the mouth-shields and under arm-plates. Upper surface of disc with larger and smaller, somewhat tumid scales, arranged in a rosette in the centre. Radial shields, not conspicuous, touching each other laterally, of equal breadth at each end. Incisions in disc bordered by ten short, broad papillæ in a close row. Mouth-shields twice as long as broad, nearly oval, rounded outwards, pointed inwards, extending far outwards into the interbrachial spaces. Side mouth-shields broader inwards, narrower outwards, and touching one another for some distance. Innermost tentacle-pores opening into the outer end of the mouth-slits. All the tentacle-pores oblique, while in the preceding species only the innermost pair are thus placed. From one to five tentacle-scales, according to distance from the disc. Two or three arm-spines, so short as to be like papillæ. Arms short, thick, pointed, knotted, often only twice as long as diameter of the disc. Upper arm-plates, near disc, hexagonal. Under arm-plates very narrow, the innermost in contact with each other, but the outermost separated by the overlapping side arm-plates. The diameter of the disc reaches 8½mm., the length of the arms 17mm. Greenland, Newfoundland.

Ophiura Stuwitzii (Lütken).—Lütken, p. 49, Tab. I, fig. 8.

Disc thick, high, pentagonal. Arms short, acute, conical. Upper surface of disc with rounded, angular scales, decreasing in size from centre to periphery; under

surface with small scales. Radial shields short and broad, touching each other outwards, but within separated by a round scale. Incisions in disc shallow but wide, admitting two upper arm-plates. The scales which border the incisions run parallel with the arm-plates, so that their combs of papillæ look like the innermost rows of arm-spines; on each side, eight of these flat papillæ growing stronger above. Traces of papillæ along the genital openings. Mouth-shields twice as long as broad, narrow, rounded without, within pointed. Side mouth-shields narrow and placed within mouth-shields proper. Mouth-papillæ small on side of mouth-frames, but at the inner end, larger and pointed. Under arm-plates, at base of the arms oblong, tumid, distinctly separated from surrounding parts; but, a little further out, not raised, and having a pentagonal, or hexagonal shape. Tentacle-pores oblique. Along the outer edge of each side arm-plate, and so along the inner edge of each tentacle-pore, runs a close row of seven broad, flat papillæ, among which it is not possible to distinguish arm-spines from tentacle-scales. The innermost joints of the arm have tentacle-scales also along the outer edge of the tentacle-pores. In outer joints of arm, only one tentacle-scale and three arm-spines. Upper arm-plates, at base of arms, trapezoidal; further out, rudimentary and triangular. Diameter of disc $6^{mm.}$; length of arms $10^{mm.}$ Greenland; Newfoundland.

Ophiocten Kröyeri (Lütken).—Lütken, p. 51, Tab. I, fig. 5.

(Syn. *Ophiura sericea* [Forbes]? Sutherland's Journal of a Journey, &c.).

Upper and under integuments of disc separated by a distinct line. Below, naked, rounded scales; above, with ten somewhat oval radial-shields, a rosette of plates in the centre and other plates scattered radiately, all of which are separated from each other by a close covering of fine grains, so that the back resembles a pavement of smaller and larger stones. Incisions in the disc only indicated by bends, which are bordered by a continuous row of papillæ. On the outer edges of the two or three first upper arm-plates, a row of papillæ. Mouth-shields a little longer than broad, of a regular shield-shape; side mouth-shields narrow; mouth-frames conspicuous. Arms rather long and thin. Upper arm-plates broad and bounded by straight cross-lines. Under arm-plates small but proportionately broad, entirely separated by the overlapping side arm-plates. Three arm-spines, about as long as the joints. One tentacle-scale, except the innermost pair of pores, where there are four. Mouth-papillæ, four or five on each side; teeth pointed as in *Ophiura*. The diameter of the disc may reach $15^{mm.}$ Spitzbergen, Arksut (South Greenland), 15 to 20 fathoms.

Amphiura Holbölli (Lütken).—Lütken, p. 55, Tab. II, fig. 13.

[Ophiolepis Sundevalli (Müll. & Trosch.)?]

Disc flat, with very fine scales below; those above small, except some larger in the centre. Radial shields small, oblong, twice as long as broad, narrower inwards, separated by a wedge of three to five scales. Mouth-shields small, angular, rounded, a trifle longer than broad. The madreporic shield larger, and porous on its edge. Side mouth-shields broad, heart-shaped and lying within the mouth-shields. Teeth square and broad, below them a pair of stout mouth-papillæ; another pair at the outer end of the mouth-slits, and a third, lying above the second. Upper arm-plates twice as broad as long, transversely oval. Under arm-plates in contact, pentangular. One tentacle-scale. Four to five short, thin spines, as long as the joints. Color whitish. Greenland (Jacobshavn, Godhavn, Arksut). 15 to 50 fathoms. Diameter of disc $5^{mm.}$; length of arms $35^{mm.}$; but it grows larger.

Asterophyton eucnemis (Müll. & Trosch.). Young.

Young specimens with a disc of $3^{mm.}$, have the arms only once divided; at $4\frac{1}{2}^{mm.}$, twice, at $6^{mm.}$ the arms are divided thrice, and the disc is uniformly covered with tolerably large grains, but there is, as yet, no appearance of ribs.

OPHIURANS OF GREENLAND.

Ophiura Sarsii (Lütken).
Ophiura squamosa (Lütken).
Ophiura Stuwitzii (Lütken).
Ophiura nodosa (Lütken).
Ophiocten Kröyerii (Lütken).

Amphiura Holbölli (Lütken).
Ophiopholis aculeata (Lütken), (*Ophiolepis scolopendrica*, Müll. & Trosch.).
Ophiacantha spinulosa (Müll. & Trosch.).
Asterophyton eucnemis (Müll. & Trosch.).

As before mentioned, *Amphiura Holbolli* may be *Ophiolepis Sundevalli* of Johannes Müller; while Stimpson's *Asterophyton Agassizii* is probably the same as *A. eucnemis;* and his *Ophiolepis ciliata* is *Ophiura Sarsii*. To the above list is to be added a naked Ophiuran with soft skin and long thin arms, probably an *Ophioscolex;* but no good specimens have yet been obtained. If *O. arctica* turns out not to be a mere variety, there is still an eleventh species.

Finally, *Ophiothrix fragilis* has been reported from Greenland, and other very cold localities; but this is perhaps more than doubtful. On the Scandinavian coast, from Cape Kullen, in the south of Sweden, opposite the north point of Zealand, to Lofoten, on the northwest coast of Norway, there are found nineteen species of Ophiurans. On the shores of Finmarken (northwest coast of Norway) there are, thus far, six species; and on those of Great Britain, thirteen species. The geographical distribution of the Ophiurans of Greenland is as follows:

Ophiocten Kröyeri, *Amphiura Holbölli*,	Greenland and Spitzbergen, limited to the arctic zone.
Ophiura nodosa, *Ophiura Stuwitzii*, *Asterophyton eucnemis*,	Only in the western Atlantic; at Greenland and Newfoundland.
Ophiura Sarsii, *Ophiacantha spinulosa*,	Essentially arctic, though found in the northern temperate sea-belt, as well as at Spitzbergen and the European and American coasts of the polar sea.

Ophiopholis aculeata—On both sides of the Atlantic, through the whole arctic and cold temperate zones. *O. squamosa* has probably the same range.

Art. VIII.—*On a Visit to the Recent Eruption of Mauna Loa, Hawaii;* by Prof. Robert C. Haskell, of Oahu College, Honolulu. (From a letter to one of the Editors).

Our party consisted of Pres. Beckwith, Prof. Alexander, myself and twenty students of the college. Twelve of us went to the source of the flow. Only two persons besides have thus far reached it, though many have visited the stream on the plain between Hualulai, Mauna Kea and Mauna Loa.

The eruption broke out on the 23d of January. No earthquake was felt in any part of the Islands at the time, but dead fish were noticed on the 21st and for a few days afterwards, to the east of Molakai and between Molakai and Oahu. The fish gave no evidence of disease, but seemed to have been parboiled. At Honolulu, 200 miles from the eruption, the atmosphere was exceedingly hazy and thick. So much was this the case that it caused considerable excitement, before the news of the eruption arrived.

Rev. Mr. Lyons of Waimea states that on Sunday afternoon, Jan. 23d, smoke was seen gathering on Mauna Loa. In the evening, lava spouted up violently near the top of the mountain on the north side, and apparently flowed both towards Hilo and towards the west side of the island. This continued but a few

minutes, when at a point considerably farther below the top and farther west, another jet spouted up.

Accounts from Hilo say, that on the night of the 23d it was so light there that fine print could be read without difficulty. After the 23d the light was much less.

At Lahaina, more than 100 miles distant, the whole heavens in the direction of the eruption were lighted up.

Our party started from Honolulu Feb. 1st, and reached Kealakekua on the 3d. Here we learned that the stream from the eruption had reached the sea on the 31st of January, at Wainanalii, about forty miles from the place of eruption. This makes the average progress of the stream above five miles per day. After procuring guides, natives, pack-oxen and mules we started for the source of the flow on the 5th. About noon we had a *view* of the source distant probably 25 miles from us in an air line. The crater was about 150 feet high and 250 feet in diameter (as we afterwards estimated). From within this crater, liquid lava was spouting up to the height of 300 or 400 feet above the top. In shape and movement it resembled a mighty fountain or jet of water, though more inconstant. At one moment it was uncommonly high and quite narrow at the top, at the next not as high but very broad. At night and from a good position near, the view of the jet, according to Mr. Faudrey (the only man who reached the crater while the jet was spouting) was grand beyond all description.

Owing to an accident which befell one of our party, and the failure of water where it was supposed to be abundant, we were delayed two days and induced to divide our party into two divisions. One part returned to visit the flow at a point some twenty miles below by another and easier route. The party who went on, consisting of twelve white persons and thirty kanakas, reached the crater Wednesday evening, Feb. 9, and encamped about two miles from it. Here all fears about water were at an end, for we found snow in abundance within half a mile of our camping-ground. In the evening our view was magnificent. The jet had ceased to play; but two craters, about eighty rods apart, were sending up gas and steam, with appearances of flame. This apparent flame, however, we afterwards ascertained was only fine particles of scoria heated to redness. The noise attending this action was like that of an ascending rocket, very much increased of course, but quite irregular. About half a mile below the lower of the two craters, the stream first made its appearance. For five or six miles its course was well defined, and there were no side-streams. From this point the main stream divided more or less, and on the plain, between the three mountains Hualalai, Kea and Loa, the branches extended over a breadth of three or four miles. Some of these

streams were very broad and sluggish and partially cooled, some were narrow and running, as it seemed, at the rate of two or three miles per hour, burning the jungle and trees before them and vieing with each other in their work of desolation.

For the first few miles the stream appeared to be a series of cataracts and rapids. As it approached the plain between the two mountains, it gradually changed into a net-work of streams, or a lake of fire, embracing numerous islands and sending out streams on all sides. The color of the stream upon its first appearance was a light red approaching to white; on the plain a deep blood-red. From the plain towards Wainanalii the stream was narrow, varying from half a mile to a mile in width, and showing only a dull reddish light.

Such was the view spread out before us. To say that it combined the magnificence of a conflagration with the sublimity of a mighty mountain torrent, may give some idea of it; yet such was the extent and variety of the scene that no adequate comparison can be found. The next morning we moved our camp down to the new lava, about half a mile from the lower crater. Here we melted snow, cooked our food, and boiled our coffee over steam cracks. The day proved very foggy and rainy, but we were able to make some explorations about the craters. On the windward side we could ascend them and look in, though the heat was so great that we could look for a moment only, before turning our faces away. The sulphurous gases also were so strong that we were obliged to close our mouths and noses as we approached to look in. The craters were both very irregular in shape, not only on the outside but in the inside. No liquid lava was seen in either at the time. In each there were two or three separate holes where gases and steam were issuing. The sides of these holes and indeed the entire bottom of the craters were at a white heat. The lava stream appeared to be running underneath these craters, and the holes within seemed to be merely vents for the escape of gases. The craters were formed of fragments of light scoria and lava combined. The lower of the two (the one in which the jet was thrown up for fifteen days) was now open on the lower side. This was not the case while the jet was thrown up, according to Mr. Faudrey. It would seem that the force of the jet broke down the lower side, and that after this the jet ceased to play. The upper crater was closed on all sides.

Above these two craters we visited a third not then in action, but still hot. This was smaller and open on the lower side, and broken down somewhat on the upper side. This was formed, not so much of scoria as of old lava. Above this we could see others still of the same kind, and it is probable that they extend to the place where the lava first spouted out. From that place

to the craters then in action, the stream appears to have flowed under the surface mostly, but to have been forced up to the surface where these craters now inactive appear, by hydraulic pressure, or by the pressure of gases, or by both combined.

The next morning we visited the point where the stream first made its appearance. Here we found the lava rushing out from its subterranean passage, and dashing over cataracts and along rapids at such a rate that the eye could scarcely follow it. The lava was at a white heat and apparently as liquid as water. Only a few feet from where the stream issued, small masses of lava were thrown up from ten to fifty feet into the air, which cooled in falling. The cause of this without doubt was the escape of gas, and we then thought that the gas might come from the stream itself. But about three hours afterwards we returned to the same place, and found that the action had greatly increased. Gases were escaping at two other points a few rods below the point first seen. Pieces of lava were thrown as high as 150 feet, and, at the lowest of the three points, there was a fountain some twenty-five feet high. The bits of lava thrown up cooled as they fell, and had already formed craters ten feet high around two of the points where gases were escaping. It was now evident that the escaping gases were not derived from the stream simply, but issued from a vent, which reached to the common reservoir within or under the mountain. We could not remain to watch this incipient crater and fountain, but we were obliged to commence our return. At night, however, from our encampment, about twelve or fifteen miles below, we could see that the crater had increased considerably and also could see the fountain playing a few feet above, but the course of the stream had now changed in part, and half or more of the lava passed down by a new stream. This dashed all our hopes of seeing another large jet of 300 feet in height; and from a friend of mine who visited the spot three or four days afterwards, I learn that the fountain had ceased, and that the crater increased only a few feet after we left.

Descending by the stream, we were able to follow it on its south side, as a strong wind was blowing from that direction. Here we found good walking, and could with safety approach within a few feet of the channel. The width of the stream was from 20 to 100 feet, but its velocity almost incredible. Some of our party thought it 100 miles per hour. We could not calculate it in any way, for pieces of cold lava thrown into it would sink and melt almost instantly. The velocity certainly seemed as great as that of a railroad car. For eight or ten miles the stream presented a continued succession of cascades, rapids, curves, and eddies, with an occasional cataract. Some of these were formed by the nature of the ground over which it flowed,

some by the new lava itself. The stream had built up its own banks on each side, and had added to the depth of its channel by melting at the bottom. The stream flowed more gracefully than water. In consequence of its immense velocity and imperfect mobility, its surface took the same shape as the ground over which it flowed. It therefore presented not only hollows but ridges. In several places for a few feet the course of the stream was an ascent of five to ten degrees, in one instance of twenty-five. Where the turns in the stream were abrupt, the outside of the stream was much higher than the inside. So much was this the case, that the outside sometimes curved over the inside, forming a spiral. It is needless to add that we were filled with wonder and admiration at the sights we saw.

After arriving at the plain between the mountains we had so much fog and rain that we could explore but little. We however saw "*pahoihoi*" or solid lava forming, and also "*aa*" or clinkers. "Pahoihoi" was formed mostly by small side streams and always by shallow streams, which flowed freely but slowly. They were derived generally from the overflowing of the main stream. After flowing for some distance they became cooled at the end, and as there was little pressure from behind, gradually stopped. The little ridges which give the "*pahoihoi*" a ropy appearance, were caused by the flowing on of the stream for a little after it had cooled forward. These are circular because the sides of the stream cool first, while the centre moves on a little farther. These streams become solid in a short time, cooling through, and not simply coating over. At a subsequent time during the same flow, another layer of "*pahoihoi*" may be formed upon the first, as we saw in several instances.

The clinkers are always formed by deep streams, and generally by wide ones, which flow sluggishly, become dammed up in front by the cooling of the lava and in some instances cooled over the top, forming as it were a pond or lake. As the stream augments beneath, the barriers in front and the crust on the surface are broken up, and the pieces are rolled forward and coated over with melted lava which cools and adheres to them more or less. Then, from the force of the melted lava behind and underneath, the stream rolls over and over itself. In this way a bank of clinkers ten to forty feet high, resembling the embankment of a railroad, is formed. Often at the end of the stream no liquid lava can be seen, and the only evidence of motion is the rolling of the jagged rocks of all sizes down the front of the embankment. Sometimes the stream breaks through this embankment and flows on for a time until it gets clogged up again, and then the same processes are repeated. In this latter case the outbursting stream often carries as it were on its back immense masses of clinkers, which look like hills walking. We found no clinkers

until we reached the plain, and it would seem that none are formed except where the descent is but little, or the lava but imperfectly melted.

There is only one point more of which I will speak. I am not quite satisfied that there is a fissure in the side of the mountain, through which the lava made its exit to the surface. Those of our party who had seen the flow of 1840 and who had no doubt of a fissure in the side of the mountain then, think that there is no fissure in this case. I do not of course believe in the old theory of a perpendicular duct or pipe reaching down to the reservoir of lava, but it seems to me that the lava by the pressure of gases and steam works its way to the surface as the water of springs by hydraulic pressure. Hydraulic pressure also constitutes a part of the force which impels lava. Mauna Loa is full of caves, passages, &c., and very porous, and besides the lava, in case of this flow at least, could melt its way more or less, where it met obstructions. It may be, however, that there is a rent in the side of the mountain.

NOTE.—We have received from Prof. Alexander of Honolulu a map giving the course of the lava, and enabling us to make a correction in the map published in the last number of this Journal. The course there given was copied from the "Commercial Advertiser" of Honolulu. It requires only that the current should be made to flow west-north-west from near its point of starting, and then on reaching the base of Hualalai, bend northwestward into the course given in the map.—EDS.

ART. IX.—*On some points of Agricultural Science;* by SAMUEL W. JOHNSON, Professor of Analytical and Agricultural Chemistry in the Yale Scientific School, and Chemist to the Connecticut State Agricultural Society.

The Absorptive properties of Soils.—It has long been vaguely known, that the soil possesses a remarkable power of absorbing a great variety of bodies. How the soil absorbs odors (more properly the volatile matters that give the sensation of odor) has often been seen in the case of garments upon which the fetor of the American skunk has fallen. The Indians long ago taught that they might be "sweetened" by burying them in the earth; and indeed we are told that these people sweeten the carcass of the skunk by the same process to render it fit for eating. Dogs and foxes bury bones and meat in the ground, and afterward exhume them in a state of comparative freedom from offensive odor.*

* It is well known that some surfaces have a much greater power of attaching odors to them than others. Every person has observed that woolen garments retain smells longer than cotton or linen ones, and it appears that the color with which a cloth is dyed affects its retentiveness for some odors. It is a fact, as the

In the older treatises on agronomy we find allusion made to the power of soils to absorb gases, and this power, especially as exercised toward carbonic acid and ammonia, has been assumed to be of much agricultural significance, although the lack of precise experimental knowledge as to its extent, has been confessed and lamented.

The absorptive power of the soil not only for odors and gases, but also for fixed matters carried into it in a state of solution, is illustrated in certain commonly occurring instances. Thus the wells in densely populated cities, or in the vicinity of barn-yards, or filthy canals, remain sweet and pure for a greater or less period of time, though they must be constantly receiving waters that have been in contact with putrefying animal matters. The filtration of the foullest water through a thin stratum of loamy earth removes all unpleasant effluvium and taste.

In the year 1850 it became known through two interesting articles published in the Journal of the Royal Agricultural Society of England,* that the soil exerts an absorptive power toward certain substances, ammonia and potash especially, but not toward hydrochloric, nitric and sulphuric acids, so that if dilute solutions of hydrochlorate, nitrate, or sulphate of ammonia or potash are filtered through, or agitated with a certain quantity of soil, the salts are decomposed, the bases remain in insoluble combination with the soil, and the acids are found in the solution united for the most part to lime.

Previous to 1850, the absorbent power of the soil was explained as a result merely of the surface attraction of porous bodies. Thus Liebig in his "Chemistry applied to Agriculture and Physiology," referred the condensation of ammonia in soils, to the surface attraction of oxyd of iron, alumina and humus, and compared this power of soils to that exhibited by charcoal, which absorbs 90 times its volume of ammonia gas, and evolves it again on moistening with water. He also says, deciding from analogy but in the absence of experimental data, and erroneously, "*the ammonia absorbed by the clay or ferruginous oxyds is separated by every shower of rain, and conveyed in solution to the soil.*"

The separation of organic odors and coloring matters from foul water by contact with earth, has been considered analogous to the action of animal charcoal, by which, for example, beer

writer has personally observed, that when a skunk has emitted its stench in the cellar of a house, the odor clings most perceptibly to *silver ware* which has been buried among napkins in the recesses of a "china closet" long after it has disappeared from every other article on the premises. It is probable that the soil, or some of its ingredients, "sweeten" a garment as above stated, by first effecting a transfer of the odorous matter from the surface of the fabric to its own surface, and then destroying it by oxydation in the same manner as operated by charcoal and platinum black. See note on p. 73.

* On the absorbent Power of Soils." By H. S. Thomson. Vol. xi, pp. 68–74; and "On the Power of Soils to absorb Manure." By J. Thomas Way, Consulting Chemist of the Roy. Ag. Society. Vol. xi, pp. 317–380; also, vol. xiii, pp. 123–142.

and wine may be deprived of odor,* color and taste, and to that of alumina which forms insoluble *lakes* with organic pigments.

Way, in his comprehensive investigations before alluded to, after studying separately as far as possible the absorptive effect of each ingredient of the soil, was led as a last resort to investigate the relations of the silicates to saline solutions. The simple silicates he found ineffectual and had recourse therefore to the complex silicates. He digested feldspar with solution of chlorid of ammonium but detected no reaction, and thence concluded that the fragments of granitic rocks could not perceptibly decompose saline solutions. In order to trace the action of such silicates as are formed to a small degree in the wet way in soils by the weathering of the granitic minerals, Way next prepared double silicates of alumina with the bases potash, soda, lime and ammonia respectively. In the first place he procured an alumina-potash- or alumina-soda-silicate, by precipitating the soluble alkali-silicates with a salt of alumina; on digesting these double silicates with solutions of lime and ammonia, he succeeded in replacing the potash and soda by lime and ammonia, though but incompletely, for different preparations of his alumina-ammonia-silicate contained but 4·51 to 5·64 per cent of ammonia instead of the quantity equivalent to the partly displaced alkali which, according to him, in case of the alumina-soda-silicate, should be 15·47 per cent.

Way gives as characteristic of this class of double silicates, that there is a regular order in which the commonest protoxyd bases replace each other. He arranges them in the following series:

Soda—Potash—Lime—Magnesia—Ammonia:

and according to him, potash can replace soda but not the other bases; while ammonia replaces them all: or each base replaces those ranged to its left in the above series, but none of those

* Several years ago Stenhouse found that the disinfecting property of charcoal depends, not merely upon the condensation in its pores of odorous matters, but also upon their destruction by the condensed oxygen with which doubtless, it is charged. The writer (after Stenhouse) has kept the carcass of a dead rat all summer long in the working room of the Yale Analytical Laboratory without its evolving any disagreeable effluvium, simply by burying it an inch deep in powdered charcoal. The only odor that is perceived, is a strong one of pure *ammonia*, and in time, all the putrefiable parts of the carcass disappear, the hair and bones only remaining. The animal matters enveloped in charcoal (or other highly porous body capable of condensing oxygen, as platinum black or platinum sponge; probably also most soils, especially those rich in humus) are completely oxydized to water, carbonic acid and ammonia (free nitrogen?), without the appearance of the intermediate and fœtid products that occur in putrefaction. The sweetening of meat by charcoal (or earth?) consists in the oxydation (eremecausis) of the putrefying surface. Stenhouse found that platinized charcoal (charcoal ignited after moistening with chlorid of platinum) makes an excellent escharotic and disinfectant for foul ulcers, and latterly the surgeon is employing permanganate of potash—an energetic *oxydizing agent*—for the same purpose.

on its right. Way remarks, that "of course the reverse of this action cannot occur." Prof. Liebig (Ann. de Chem. u. Phar., xciv, 380) has drawn attention to the fact that Way directly contradicts himself in describing the preparation of the potash-alumina-silicate, which may be obtained by digesting either the lime-alumina- or soda-alumina-silicate in nitrate or sulphate of potash, when the soda or *lime* is dissolved out and replaced by potash.

Way was doubtless led into the error of assuming a fixed order of replacements by considering these exchanges of bases as regulated after the ordinary manifestations of chemical affinity. His own experiments abundantly show that among these silicates there is no inflexible order of decomposition, nor any *complete* replacements.

Liebig, in the paper just cited, was led from this contradiction and from other considerations, to reject the conclusions of Way, especially as there was no direct proof that these double silicates exist in soils.

The recent researches of Eichhorn, "Ueber die Einwirkung verdünnter Salzlösungen auf Ackererde," (Landwirthschaftliches Centralblatt, 1858, ii, 169, and Pogg. Ann., No. 9, 1858,) have cleared up the discrepancies of Way's investigation (which is itself one of remarkable interest), and have confirmed and explained his facts.

As Way's artificial silicates contained about 12 per cent of water, the happy thought occurred to Eichhorn to test the action of saline solutions on native hydrous silicates. He accordingly instituted some trials on chabazite and natrolite, an abstract of which is here given.

On digesting finely pulverized chabazite with dilute solutions of chlorids of potassium, sodium, ammonium, lithium, barium, strontium, calcium, magnesium, and zinc, sulphate of magnesia, carbonates of soda and ammonia, and nitrate of cadmium, he found in every case that the basic element of these salts became a part of the silicate, while lime passed into the solution. The rapidity of the replacement varied exceedingly. The alkali-chlorids reacted evidently in two or three days. Chlorid of barium and nitrate of cadmium were slower in their effect. Chlorids of zinc and strontium at first, appeared not to react; but after twelve days, lime was found in the solution. Chlorid of magnesium was still tardier in replacing lime.

Four grams of powdered chabazite were digested with 4 grams chlorid of sodium and 400 cubic centimeters water for 10 days. The composition of the original mineral (I), and of the same after the action of chlorid of sodium (II), were as follows:

	I.	II.
SiO_3,	47·44	48·31
Al_2O_3,	20·69	21·04
CaO,	10·37	6·65
KO,	0·65	0·64
NaO,	0·42	5·40
HO,	20·18	18·33
	99·75	100·37

Nearly one-half the lime of the original mineral is replaced by soda. A loss of water also has occurred. The solution separated from the mineral, contained nothing but soda, lime and chlorine, and the latter in precisely its original quantity.

By acting on chabazite with dilute chlorid of ammonium (10 grams to 500 c. c. water) for 10 days, the mineral was altered, and contained 3·33 per cent of ammonia. Digested 21 days, the mineral, dried at 212°, yielded 6·94 per cent of ammonia, and also had lost water.

These ammonia-chabazites lost no ammonia at 212°, it escaped only when the heat was raised so high that water began to be expelled; treated with warm solution of potash it was immediately evolved. The silicate appears to be slightly soluble in distilled water, the solution giving with solution of iodid of mercury in iodid of potassium, the yellow coloration indicative of ammonia.

As in the instances above cited, there occurred but a partial replacement of lime. Eichhorn made corresponding trials with solutions of carbonates of soda and ammonia, in order to ascertain whether the formation of a soluble salt of the displaced base limited the reaction; but the results were substantially the same as before, as shown by analyzing the residue after removing carbonate of lime by digestion in dilute acetic acid.

Eichhorn found that the artificial soda-chabazite reëxchanged soda for lime when digested in a solution of chlorid of calcium; in solution of chlorid of potassium both soda and lime were separated from it and replaced by potash. So, the ammonia-chabazite in solution of chlorid of calcium, exchanged ammonia for lime, and in solutions of chlorids of potassium and sodium, both ammonia and lime passed into the liquid. The ammonia-chabazite in solution of sulphate of magnesia, lost ammonia but not lime, though doubtless the latter base would have been found in the liquid had the digestion been continued longer.

It thus appears that in the case of chabazite all the protoxyd bases* may mutually replace each other, time being the only

* Eichhorn's observations indicate that the combined (basic?) *water* of a silicate is also liable to be increased or removed. May not the small amount of water of many specimens of properly anhydrous minerals be thus acquired? May not in some cases the loss by ignition in minerals, be due to ammonia that has entered into combination in the same manner?

element of difference in the reactions. Natrolite however was not affected by digestion with chlorid of calcium. Eichhorn suggests that its soda is more firmly combined than that of chabazite.

These observations of Way and Eichhorn promise to yield the most fruitful results, not only to the theory of chemical geology, as elucidating the formation and alteration of minerals, but also to the science of agriculture. The explanation of the retentive power of soils which Way first proposed thus acquires an incalculable significance. It is plainly a true explanation, as now relieved from the constraint of a fixed order of affinities or replacements; though not the only or a complete explanation.

Voelcker in some valuable researches on the absorbent power of a soil for the liquids of the dung-heap (Journal Roy. Ag. Soc. of Eng., xviii, 149) first showed that it is not always true that the bases displace *lime* from soils. He found to the contrary, in one instance, that lime was fixed and potash displaced. This result, as well as the opposite behavior of ammonia-chabazite and natrolite towards solution of chlorid of calcium in Eichhorn's trials, indicate most clearly *that different silicates suffer different displacements, though in general, certain bases react more speedily and are more largely or firmly retained than others.* Obviously a great number of experiments are wanted on the behavior of other silicates, native and artificial, towards saline solutions in various degrees of concentration, and at different temperatures, as well as in mixed solutions, before we can decide many interesting questions suggested by these results; but we have undeniably an important new generalization with reference to the reactions that may occur among minerals and in the soil.

Economy of the Ammonia naturally accumulated in the soil.—Since it has been proved that enormous quantities of ammonia exist in soils in a state of such intimate combination that the usual means (boiling with fixed caustic alkalies) fails to expel it,* the important question has arisen—how may this ammonia be rendered more rapidly available to vegetation than it is, so as in many cases to forestall the necessity for nitrogenous manures.

The displacement of ammonia from the ammonia-chabazite by potash, soda and lime, indicates a partial solution of this question; and may not the remarkably diverse effects of various saline manures, e. g. common salt, gypsum, sulphates of soda and magnesia, and silicate of potash, as well as carbonate and phosphate of lime, depend, to some degree, on reactions analogous to those above described! We know that very small doses

* In 1855 the writer found that there was no limit to the evolution of ammonia, when attempting to estimate it in soils, and Dr. Mayer (Ergebnisse. Ag. Chem. Versuche in München 1 Heft.) could not recover by boiling with caustic potash nearly all the ammonia he purposely added to a soil.

of salt and gypsum, to take familiar examples, often remarkably enhance the productiveness of a soil, and as often fail to produce any good effect, either in small or large applications. Neither of the constituents of common salt is found to much extent in our usually cultivated plants, and soda is often entirely wanting.

The action of common salt and gypsum, especially of the latter, is most frequently similar to that caused by ammoniacal manures, whether these be applied to the soil or administered in gaseous form, as is now done in hot-houses by means of carbonate of ammonia, after the plan proposed by Ville, and is manifested in a more intensely green and luxuriant development of foliage, and increased content of water and of nitrogen. The "fixing power" of gypsum cannot longer be considered a useful quality of this fertilizer *in the soil*, not only because, in the merely moist soil, sulphate of ammonia would react on carbonate of lime, as Boussingault long ago demonstrated, but for the reason that the soil has itself a greater and more than sufficient power to fix ammonia, whether it be present as carbonate or sulphate. It is on the other hand the *unfixing* power of gypsum —its ability to liberate ammonia from the ammonia-silicates, that may in some cases constitute its merit.

General law of Displacement among saline Fertilizers.—We are every day drifting further from what but a few years ago was considered one of the most fixed and beneficial principles of agricultural science, viz. that a substance is chiefly a fertilizer because it directly feeds the plant, and are learning from the numerous recent and carefully conducted experiments with manures, that in very many cases we cannot safely venture to predict what will be the influence of a given application; but find in practice the strangest and most discordant results, it being literally possible to show from the experience of the farm that almost every fertilizer in use has in some instances proved beneficial to every cultivated crop, and in other cases has been indifferent or even detrimental.

We are therefore compelled more and more to regard the *indirect action* of manures, and the principle brought out by the researches of Way and Eichhorn, appears adapted more than any other yet discovered to generalize the phenomena of indirect action, and enable us to foresee and explain them. Proofs are not wanting of the actual operation of this principle in the soil.

Wolff (Naturgesetzlichen Grundlagen des Ackerbaues, 3d ed. p. 148,) found in fact that the ashes of the straw of buckwheat grown with a large supply of common salt, compared with the ashes of the same part of that plant grown on the same soil *minus* this addition, contained less chlorid of sodium but much more chlorid of potassium: there having occurred *an exchange of bases* in the soil.

The probabilities already adduced in favor of the view that ammonia is made available by gypsum, carbonate of lime, &c., are in point, and in the further course of this article other evidences will be brought forward to the same effect. May not the influence of lime and guano (or the carbonate of ammonia resulting from its decomposition,) in some cases be partly due to their fluxing the anhydrous or non-absorbent silicates of the soil, thus giving origin to absorbent silicates, as well as to their displacing effect on silicates already existing?

But it is of little use in the absence of decisive investigations to speculate on these topics except for the purpose of exciting research. A great field is opened here and with this new clue to guide us it should be speedily explored.

Not merely the bases, but, as *a priori* would seem entirely reasonable, the acids also appear to be capable of similar exchanges and substitutions.

Way, Liebig and others, have repeatedly observed that phosphoric acid is absorbed by soils, and from the trials of Voelcker before referred to it would appear that among the acids there occur displacements analogous to those established between the bases. Thus in one experiment in which the drainings of a manure heap were passed through a soil, there were found in an imperial gallon—

	Before filtration through the soil.	After filtration through the soil.
Silica,	·75	2·38
Phosphates of lime and iron,	7·90	1·54
Sulphate of lime,	2·18	7·92
Carbonate of lime,	17·46	79·72
Carbonate of magnesia,	12·83	6·17
" " potash,	85·27	4·29
Chlorid of sodium,	22·85	18·90
" " potassium,	85·25	26·44

In another case were found

	Before filtration through the soil.	After filtration through the soil.
Silica,	4·75	15·08
Phosphates of iron and lime,	36·32	33·14
Sulphate of lime,	7·14	*trace.*
Chlorid of sodium,	50·91	48·48
" " potassium,	30·32	39·49
Carbonate of potash,	148·69	85·93

The entire analyses have not been quoted as I do not now intend to discuss these results fully, but merely wish to direct attention to the fact that in both instances silicic acid (perhaps *only* as the result of an excess of carbonate of potash in the dung-liquor to which the soil was subjected) has been removed from the soil, and phosphoric acid has been fixed by it, while in one case sulphuric acid has been retained and chlorine lost by the soil, and in the other case the reverse has occurred.

Liebig in the paper before referred to remarks that "a clay or lime-soil poor in organic matter, withdraws all the potash and all the silicic acid from a solution of silicate of potash; whereas one rich in so-called humus (humic acid), extracts the potash, but *leaves the silicic acid* in solution."

Oxyd of iron and alumina, or some of their compounds which are present in all soils, are the most obvious means of fixing the phosphoric acid of soluble phosphates, and Thenard (Compt. Rend. Feb. 1, 1858,) has experimentally demonstrated that they do remove phosphoric acid perfectly from solutions of phosphate of lime in water saturated with carbonic acid. Déhérain (quoted in Landwirthschaftliches Centralblatt, 1859, i, 94,) has shown on the other hand that carbonate of lime and ferric phosphate brought together with highly carbonated water, give rise to phosphate of lime and ferric carbonate. According to the same experimenter phosphate of alumina and ferric phosphate are also decomposed by contact with solutions of the alkali-carbonates. Thenard in the paper just cited asserts that silicate of lime and phosphate of alumina decompose each other in carbonated water. However complicated and obscure these reactions may be, it is plain, that, henceforth, *the effect of a solution of one base in displacing other bases from native hydrated aluminous (and ferric?) silicates, and of one acid upon the compounds of other acids with oxyd of iron and alumina, must be considered in the theory of the action of saline manures.*

Water as the medium by which the ingredients of the soil enter the plant.—From his experiments on the absorbent power of soils Way was led to question the influence of water in effecting the distribution of plant-food in the soil, and Liebig in a recent paper on this subject (Uéber einige Eigenschaften der Ackerkrume" Ann. der Chem. u. Phar. cv, 109 et seq.*) has drawn the conclusion that this force in the soil is so powerful that ammonia, potash and phosphoric acid when applied as manures are instantly made quite insoluble, so that we must relinquish the idea hitherto entertained that plants appropriate their food directly from an aqueous solution, and must adopt as an only alternative the doctrine that the roots of the plant themselves attack and solve their nutriment. Liebig is of the opinion that the bodies mentioned cannot be distributed in the soil by the ascending and descending streams of moisture which are perpetually circulating in it, in obedience to gravitation and evapotion, and he adduces analyses of river, spring and drain waters, which are almost free from potash and ammonia to sustain this view.

On the other hand Eichhorn in the paper already referred to, found that *pure distilled water dissolved from a soil much more of*

* See also his "Letters on Modern Agriculture," London, 1859.

all the mineral matters required by vegetation than would be needful to supply any average crop. Henneberg and Stohmann (über das Verhalten der Ackerkrume gegen Ammoniak u. Ammoniaksalzen, Ann. der Chem. u. Pharm. cvii, 170) found that when a soil had been saturated with ammonia, pure water removed it again to a certain extent. Thus 100 grams of soil were treated with 200 c. c. of a solution of chlorid of ammonium (containing 0·698 grams ammonia) and absorbed 0·112 grams of ammonia; on removing one-half of the solution and substituting as much pure water the soil lost 0·009 grams of ammonia as the result of the dilution: by again replacing with water 100 c. c. of the thus diluted solution, 0·014 grams of ammonia were redissolved from the soil, and by five repetitions of this process 0·053 grams or nearly one-half the quantity of ammonia originally absorbed passed again into solution.

Liebig himself in one of his papers (Ann. der Chem. u Pharm. cvi, 201,) has furnished the best illustration of the manner in which one base is made soluble by being displaced from its combination with the soil on the addition of another base. He says—"If sulphate of ammonia in very dilute solution, is brought in contact with soil saturated with silicate of potash, and which does not give up a trace (?) of its potash to water alone, it instantly dissolves a certain quantity of this alkali, which may be easily detected by the common reagents."

Liebig has not overlooked the case of aquatic plants whose roots do not enter any soil, for which, he remarks—"there must of course exist other laws for the absorption of their mineral food; they must absorb it from the surrounding medium."

But there appears to be no reason for supposing that aquatic plants differ from our cultivated crops in the manner of imbibing or appropriating the nourishment which enters the roots, especially since Sachs and Stoeckhardt (Chemischer Ackersmann 1859, p. 28, *et. seq.*) have shown that the cereals and leguminous grains, as well as clover and beets, not only germinate but attain a vigorous development and even blossom; although their roots never come in contact with a solid soil, but merely float in water holding in solution the salts needful to supply them with mineral food.

It must be borne in mind that the amount of mineral (fixed) ingredients in a plant or crop is but a minute fraction (according to Boussingault $\frac{1}{1300}$ on the average, according to Lawes and Gilbert $\frac{1}{3000}$) of the quantity of water which a plant or crop under usual circumstances transpires during its season of growth. We are not surprised then, that agricultural plants are sufficiently fed when their roots are merely surrounded by ordinary well water which is daily changed, or by distilled water mingled with a little vegetable ash into which carbonic acid is daily con-

ducted. We know that drain tubes and aqueducts are often choked by a mass of rootlets which have grown from one little fiber that made its way into them through a narrow crevice, but why should the roots of trees and land plants thus develop in such water unless they find their food in it? In Stoeckhardt's experiments *loc. cit.*, it was observed that rye and oats only developed in a normal manner in saline solutions, when these were diluted from six to ten thousand times! and young clover plants grew luxuriantly, putting forth new roots, leaves and blossoms in profusion, when transferred from the soil to pure water supplied with carbonic acid, to which was added $\frac{1}{1000}$th of clover ashes that had been neutralized with nitric acid.

It is true that most river and spring waters yield by analysis but the minutest traces of potash, ammonia and phosphoric acid, but we cannot perhaps infer with safety that they are actually so deficient in these ingredients, for it may easily happen, as all chemists know, that in the evaporation of a large mass of water traces of salts are likewise carried off,* and in the ignition of saline residues, as is customary in the analysis of a water, much more loss of potash may occur from the ready volatility of chlorid of potassium.

But admitting that our analyses are sufficiently accurate to base calculations upon, and that the soil-water never contains more potash for example than river and well waters; viz., from 2 to 10 parts in 1,000,000,† it must be remembered that the plant is by no means compelled to limit itself for its supplies of mineral matter to that portion of water which it transpires.

The root-cells of a plant placed in a saline solution at once establish osmotic currents, in virtue of the mutual but unbalanced attractions that exist between the cell-walls, the liquid of the cell, the surrounding liquid and the saline and organic matters in solution in these liquids. The assimilating processes going on in the cells are constantly transporting matters forward into the newer growths; or else removing them from solution in the sap, and causing their deposition in the solid form. These are the prime disturbances that operate the currents, and to restore the matters thus removed from the liquids of the root-cells, external matters held in solution diffuse inwardly. If a plant has a large leaf surface exposed to the free air, from which water rapidly evaporates, water diffuses into the root-cells if it be

* In Liebig's Chemistry applied to Agriculture and Physiology (5th German ed., p. 102, et seq.) may be found an account of some of the more striking instances of this volatilization. My friend, Dr. Robert A. Fisher permits me to mention the result of some of his researches that bear on this point. He found in fact that a quantity (very small indeed but still sufficient to be estimated by volumetry) of *caustic potash* is carried off in the vapor when its aqueous solution is distilled.

† Eichhorn found in 1,000,000 parts of distilled water that had been in contact with a soil for ten days, 57 parts of potash.

present in the soil, and thus the normal humidity of the structure is preserved. But if the plant be situated in a close hothouse, or in a Ward's case, the atmosphere of which is constantly saturated with aqueous vapor, there can be no evaporation of water from the leaves, there can be no transpiration of water through the plant and no absorption of it by the roots, except to supply what becomes a solid constituent of the tissues or is decomposed in the nutritive process. The same is true of potash or any other substance held in solution in the soil-water. As a result of this principle the land plant collects the potash, phosphoric acid, silica, &c., needed for its organization, from the vastly dilute solutions of these bodies which form the water of wells or of the soil, just as the fucus gathers its iodine from the ocean, although the marvellously delicate reagents which we possess for iodine scarcely enable us to detect this substance even in highly concentrated sea-water.

Says Gmelin, (Handbook of Chemistry, Cavendish Soc's. ed., vol. ii, p. 248,) "the quantity of iodine contained in sea-water is so small that Tennant, Davy, Gaultier, Fyfe and Sarphati were not able to find it. Balard, however, found it in the water of the Mediterranean and Pfaff in that of the Baltic, which is nevertheless very poor in iodine." Otto (Lehrbuch 3d ed., 1st Part, p. 452,) observes "while bromine is easily found if not in the sea-water itself, yet in the mother-liquors obtained by its evaporation, and is prepared from them in large quantities, it is still doubtful if iodine can be detected in them." Again in a note—"It is worthy of remark that in preparing bromine from the mother-liquors of sea-water, iodine, so far as I know, has never made its appearance."

Iodine can be detected in a solution of which it forms but $\frac{1}{300000}$th part—Otto.

The *selecting power* which is possessed by plants is fully explained and defined by osmotic diffusion. Within certain easy limits the plant imbibes only those kinds of matter and those quantities, which it requires to develop its organism, and which diffuse into it in consequence of assimilation in the cells. These limits are not so narrow or inflexible as to make the finding of the conditions of growth impossible, and within them, the plant lives and expands, but is itself influenced in its life and in the direction of its enlargement, by the quantities, absolute and relative, of the nutritive or soluble matters, that happen to surround it. Could we grow two plants in precisely identical conditions, we should find their composition alike in all their parts. The variations in the composition and amount of the ash of plants is probably connected with the different relative development of the separate organs, and this again (in part) with the relative quantities of food present in the soil water. Thus the ash of

the plant is to a certain extent independent of the soil, but again to a certain extent is affected by it. The absorption of *poisons* by plants is entirely abnormal and does not affect our statement.

Not only does the grand law of osmose (endosmose and exosmose) feed the plant out of such attenuated solutions, but, in all probability it aids the formation of these solutions. Graham has shown in the case of alum and bisulphate of potash that the unequal diffusive tendency of the members of a double salt is powerful enough to decompose it, and he observed that solutions even of the neutral sulphates of potash and soda diffused their basic ingredients into lime-water, more rapidly than the acid; these stable salts thus undergoing partial decomposition.

The investigations of Henneberg and Stohmann already cited, have proved that the absorbent power of a soil is not a purely chemical process, in the ordinary restricted sense; but is in part a physical phenomenon, i. e., it does not depend exclusively upon the presence in the soil, of a certain amount of some peculiar *kind* of matter, but is also related to the *condition* and to the relative amount of acting surface of the various materials which react.

Henneberg and Stohmann found that the *time of contact* between a solution of an ammonia-salt and a soil did not affect the amount of absorption,—as much ammonia being taken up in four hours as in a week. This fact indicates that the absorbing substance is in an extreme state of division, to which the pulverized chabazite of Eichhorn's experiments can bear no comparison.

They found too, that a given soil absorbed out of an equal volume of liquid very nearly the same amount of ammonia from equivalent quantities of all its salts, the *phosphate* excepted.

They observed however that the *relative quantities* of soil, water and the saline substance, affected the results; thus from a stronger solution a greater absolute amount of ammonia was absorbed, while from a weaker solution a relatively greater quantity was taken up: and further, relatively more was absorbed by a given amount of soil, from a solution of given strength when the *volume* of the latter was increased.

Finally they found, as has been already remarked, that by diluting with pure water the solution from which a soil had saturated itself with ammonia, a portion of this body is redissolved.

Thus it appears that the very surface-attractions which determine the solution of solid bodies, and occasion osmotic diffusion, also operate in the soil to influence the chemical affinities which are the prime cause of its absorptive properties. The chemical affinity of silicate of alumina for the bases, (probably too that of oxyd of iron and alumina for some of the acids) is modified by the mass of the reacting substances and by that of their solvent; or in other words the cohesive force of the atoms of the com-

pound silicates, or the adhesive force of water, (solvent action) for the saline bodies, may neutralize or limit the chemical affinity which determines one compound and give origin to another. Hence the chemical substitutions in the soil, and in the case of chabazite: hence too the perpetual presence of all the mineral food of plants in the water of the soil.

We would not by any means deny the direct action of the rootlets of plants upon the soil, an action which though exceedingly obscure and as Prof. Liebig remarks in enunciating his new views "very difficult to form a conception of," we may admit in some cases.

Liebig in his letters on modern agriculture, p. 43, gives this instance: "We frequently find in meadows smooth lime-stones with their surfaces covered with a network of small furrows. When these stones are newly taken out of the ground, we find that each furrow corresponds to a rootlet, which appears as if it had eaten its way into the stone." We may admit in this case that the rootlets have acted upon the stone, but are not therefore necessarily compelled to assume that the dissolved matters have entered the plant or were dissolved as food, for in such lime-soils the excess rather than the deficiency of carbonate of lime is oftener a hindrance to vegetation. In the case of the *Lycopodiaceæ*, which contain *alumina* in large quantity combined with tartaric acid, (Berzelius) or malic acid (Ritthausen) we are, if any where, obliged to look to the plant itself, to account for the entrance into it of a substance absent from all cultivated plants if our numerous analyses are to be credited, and one which is rarely found in river waters, and then in quantity so small as to excite the suspicion that it has been introduced in the reagents, or came from suspended matters.

But it is evident from the facts that have been adduced that it is unnecessary to have recourse to any new theory to explain the access of the soil-ingredients into the plant. In fact it would appear that the view we have felt forced to sustain is the only one admissible in the present state of knowledge—the only one conformable to what we deem well established physical laws.

Conclusion.—The function of the soil.—While the researches of Eichhorn are of the utmost value in aid of the theory of the absorption of fertilizing matters by the soil, they do not suffice to give a full explanation of this process. Doubtless all the reactions that occur between hydrous silicates, sesquioxyds and saline solutions may take place in the soil; but in addition to these a number of other changes must go on there, as the soil is so complex and variable a mixture. The organic matters (the bodies of the humic acid group), which are often though not always present in no inconsiderable quantity in the water extract of fertile soils, can hardly fail to exert an influence to modify the action of the silicates. I have found that a peat (swamp-

muck) from the neighborhood of New Haven, (containing when fully dry 68 per cent of organic matter) which is highly prized as a means of improving the porous hungry soils in this vicinity, and which when drained grows excellent crops, is capable of absorbing 1·3 per cent of ammonia, while ordinary soil absorbs but 0·5 to ·1 per cent.

The great beneficent law regulating these absorptions appears to admit of the following expression: *those bodies which are most rare and precious to the growing plant are by the soil converted into, and retained in, a condition not of absolute, but of relative insolubility, and are kept available to the plant by the continual circulation in the soil of the more abundant saline matters.*

The soil (speaking in the widest sense) is then not only the ultimate exhaustless source of mineral (fixed) food, to vegetation, but it is the storehouse and conservatory of this food, protecting its own resources from waste and from too rapid use, and converting the highly soluble matters of animal exuviæ as well as of artificial refuse (manures) into permanent supplies.

Yale Analytical Laboratory, May 15th, 1859.

ART. X.—*On Fossil Plants collected by Dr. John Evans at Vancouver Island and at Bellingham Bay, Washington Territory.*—In a letter from L. LESQUEREUX to J. D. DANA, dated Columbus, Ohio, May 12, 1859.

Dear Sir,—Supposing that Prof. Heer who is now engaged in publishing a magnificent *Fossil Flora of the Tertiary* of Europe, would be much interested in the examination of the plants of Dr. John Evans' survey, of which a short description is published in the last number of your Journal, I sent him a sketch of the drawings prepared for Dr. Evans' report. I have just received an answer to the communication, and as it fixes the value of my species and gives some opinions which are of great interest to American geology, I take the liberty of translating a part of his letter and sending it to you for publication.

Prof. Heer says: "I have hailed with the greatest delight the news which you give me in your letter of 21st March. They are the first rays of light penetrating the dark night which until now has covered the tertiary flora of America, and the day is close at hand, when the fog which still darkens the wonderful flora of those times will be uplifted, and the New World open to us its treasures. They will prove of the greatest interest for the natural philosophy of the earth, and give us most important information as to the relation of climate at the tertiary epoch, and to the secular progression or distribution of temperature over the whole earth. But it is also of the greatest importance for the

history of the American flora, to discover through the plants of the tertiary the various elements of which it is composed; the time will surely come when we shall be acquainted with the true characters of the different floras and with the history of their formation."

"You very correctly remark that the examination of the tertiary flora of Oregon and Vancouver shows that the flora is nearly related to the European flora of the same epoch. Among your species, we find some which are considered as particularly characteristic of our tertiary; viz. the species of *Cinnamomum*. *Cinnamomum crassipes*, Lsqx., is hardly distinguishable from *C. Rossmaesleri*, Heer. It is a pity that the point of the leaf is wanting; it would at once decide the matter, showing whether the nerves ascend to the point or disappear below it, as is the case in *C. lanceolatum*, which is also very similar.—*Cinnamomum Heerii*, Lsqx., is not so certain in its identity. At any rate, it would better agree with *C. polymorphum* than with *C. Buchii*, which is broader just above its middle. What makes me doubtful here, is that the fine nervules emerge at an acute angle, while in *Cinnamomum* they have a somewhat different direction. Perhaps your drawing in this is not quite correct, for in every other respect, the leaf as far as it is preserved would well agree with our *C. polymorphum*. As to *Planera*, I perfectly agree with you, that it is not possible to separate it from *P. Ungeri*. *Salix Islandica*, Lsqx., in its form and general outline resembles our *Salix macrophylla*. But if the nervation is rightly marked, your leaf cannot belong to that species. In *Salix macrophylla*, as in the willows generally, we have, besides the percurrent secondary nerves united near the margins, some other shorter intermediate secondary nerves, which emerging at an obtuse angle from the medial nerve, extend to the nearest secondary nerve either above or below and join with it. In *Salix macrophylla* these shorter secondary nerves are very close together. But in your drawing I see only secondary nerves running nearly to the margins, and if it is correct your leaf does not belong to a *Salix*. The name you give to this leaf (*Salix Islandica*) is peculiar. Your leaf could not have been brought from Iceland? I received from Copenhagen a very interesting collection of the tertiary flora of Iceland, and among the leaves there are some willows which cannot be distinguished from our *Salix macrophylla*. Your maple-leaf appears to be somewhat toothed on the margins. If it is so, it would not belong to *Acer trilobatum*. However, it is not well enough preserved for ascertaining its true species. The place of your *Salisburia* is perfectly right, since a *Salisburia*, *S. adiantifolia*, has been found at Sinigaglia, which place, with Stradella and Guarenne, belongs without doubt to the upper strata of Œningen and consequently to the upper Miocene. Your leaf, Pl. 1, fig. 1, *Quercus Benzoin*, Lsqx., is the most interesting of your species;

as it seems so perfectly to agree with *Oreodaphne Heerii*, Gaud., that there is scarcely a doubt of the identity of the two species. But your leaf does not show the small holes or depressions marked in the axils of both the inferior secondary nerves. You probably did not remark them. I beg you will again examine the specimen, and I feel confident that you will find there a small depression; if so, the identity of species is proved. The form and nervation of the leaves are truly peculiar and already sufficient for identification. *Oreodaphne Heerii*, Gaud., has been abundantly found in the upper Miocene and lower Pliocene of Italy, but never till now on this side of the Alps. It much resembles *Oreodaphne fœtens* of the Canary islands. You will find it figured in the paper of our friend Gaudin, which I send you. A second Italian leaf is probably your *Quercus Gaudini*, Lsqx.; I have at least seen one very like it in Gaudin's new treatise, which is not yet published, and I have not the plates on hand just now. I would take your leaf, Pl. 1, fig. 2, for *Ficus multinervis* if the secondary nerves were united in their arched points. This is not marked in your drawing. These secondary nerves are somewhat too straight to belong to *Quercus neriifolia*."

"From these few species, we can already see a near relation between the American tertiary flora and ours; and in several species, this relation passes to a true identity. We may add to your species *Glyptostrobus Œningensis*, Br., and *Taxodium dubium*, Sternb. In the U. S. Exploring Exped., during the years 1838–39–42, under the command of Ch. Wilkes, Geol., Atlas, Pl. 21, by Dana, there is a plate with figures of leaves from Frazer river, and among them, the two above named species are easily identified. Fig. 11 and 15 may belong to *Carpinus Gaudini;* but probably the margin of the leaf is not rightly drawn. Fig. 12 is like *Rhamnus Rossmaessleri* or perhaps a *Smilax*. These plants therefore confirm our conclusion."

"Another important deduction may be drawn from your plants, viz. that in the American tertiary flora, there are some Asiatic types which no longer belong to the American continent, namely *Cinnamomum* and *Salisburia;* and further an Atlantic type, the *Oreodaphne*. There is still an *Oreodaphne* in America; but the fossil species is related to *O. fœtens* of the Canary Islands. A third conclusion taken also from the same plant is that fan-like Palm trees were growing at the same time in the same latitude with *Sequoia* and *Taxodium*, and that therefore we must admit of a warmer climate in North America at that epoch. And now from this fact that a flora of the same character occurred at the tertiary epoch in Northern Europe and North America, it follows that both parts of the earth had a like warmer climate. It is a new and very important confirmation of the Atlantis! the second that I have received this month.

The first was given me by the collection of tertiary fossil plants from Iceland in which I found a *Liriodendron* (leaves and fruit) very like *L. tulipifera*, L., with six species of Pines, of which one much resembles *Abies alba*. With this, there are leaves of *Alnus*, *Betula*, *Salix*, *Araucaria*, *Acer*, *Sparganium*, *Equisetum*, &c., and in truth, species which agree perfectly with those of the tertiary flora. You will find in the general part of my Flora of the Tertiary, where I give a general survey of the tertiary flora of Europe, a detailed account of these leaves of Iceland, and also of some other parts of Europe from which I have received large collections."

"Your views of the gradation of the flora of North America agree perfectly with what we find in Europe. This led me to believe that the plants of Nebraska belong to the tertiary and not to the cretaceous formation. It is true that I have seen only some drawings which were sent to me by Messrs. Hayden and Meek; but they are all tertiary types. The supposed *Credneria* is very like *Populus Leuce*, Ung., of the lower Miocene, and the *Ettinghausiana* seems hardly rightly determined. Besides it is a genus badly founded, and which has as yet no value. All the other plants mentioned by Dr. Newberry belong to genera that are represented in the Tertiary and not in the Cretaceous. And it is very improbable that in America the cretaceous flora has had the characteristic plants of the tertiary; and this would be the case if these plants did belong to the Cretaceous."*

To this most interesting letter of Prof. Heer, I can only add a few words of explanation about his remarks on my species. I owe to the kindness of Dr. John Evans the privilege of still having his specimens in my possession; I was therefore enabled to again examine the only specimen of the leaf which according to Prof. Heer is referable to *Oreodaphne Heerii*, Gaud. Though the specimen is one of the best preserved of the collection, there is no trace of the mentioned pimples or depressions at the axils of the basilar secondary nerves as marked in the figure of M. Gaudin's memoir. One leaf agrees in its general outline and by its primary and secondary nervation with an *Oreodaphne*. But the secondary intermediate nerves are large, deeply marked, and perpendicular to the primary one; and the tertiary nervules are also mostly perpendicular to the secondary ones, well marked and mostly percurrent. This last character especially would separate our leaf from the genus *Oreodaphne* and put it rather with the oaks.—About *Salix Islandica* which I referred with

* Prof. Heer had not seen, when he wrote this, the paper by Messrs. Meek and Hayden in our last volume (p. 219), in which it is shown that the beds containing these leaves occur beneath thick strata characterized by Baculites, Ammonites and other fossils of the Cretaceous. Dr. Newberry has also identified similar leaves from beneath the Cretaceous of New Jersey (collected by Prof. G. H. Cook), and others from New Mexico; so that, if the leaves are tertiary our Cretaceous is abolished.—Eds.

doubt to *Salix macrophylla*, it is not possible to say any thing definite. The leaf is printed on coarse shaly sandstone and the secondary nerves are scarcely marked. It is from the general outline of the leaf and its denticulation, that I had to take the characters. The name *Islandica* was accidentally given as indicating a high latitude for a species of willow with such large leaves. It is truly a curious coincidence that Prof. Heer received from the tertiary of Iceland specimens of a species related to or perhaps identical with ours. *Cinnamomum Heeri*, Lesqx., is a true *Cinnamomum* in every character; but *Quercus multinervis*, figured Pl. 1, fig. 2, has apparently the points of the nerves arched and united, and is truly comparable with *Ficus multinervis* and perhaps identical with it. The specimen figured in Prof. Heer's flora is very poor, and our own is badly broken, and the points of the nerves are scarcely discernible.

ART. XI.—*Geographical Notices.* No. VIII.

RESULTS OF THE RECENT EXPLORATIONS IN AUSTRALIA.—We translate from Petermann's Mittheilungen, April, the following important survey of the results obtained in the recent explorations of Australia. It is principally based on official and authentic reports relating to the following expeditions:

1. Stephen Hack's Researches in the Gawler Mts., and at Lake Gairdner, 1857.
2. Major Warburton's Journey to Lake Gairdner, June and July, 1858.
3. B. Herschel Babbage's expedition to the region between Lake Gairdner and Lake Torrens, 1858.
4. Stuart's, Babbage's and Warburton's explorations north from Lake Campbell.

The article in Petermann is accompanied by a map of Australia between 133° and 138° long. east from Greenwich, and between 30°·30′ and 33° S. lat.

In order to obtain a clear insight into the advantages which have been gained by the numerous expeditions, we shall separately consider their scientific and practical results. In regard to the first view, the question arises about the unknown interior of the Continent. Although the newly explored area comprises only four degrees of longitude and as many of latitude, not extending yet one third of the distance between Spencer's Gulf and the Gulf of Carpentaria, there is new reason to assume, that the interior formation and condition of Australia have a far more varied character, than has been generally supposed. It is shown, that there is no uniform desert of stone and sand, but a

succession of tracts of lands useless and useful, part already inhabited and part capable of being so. The lake district west of the Torrens Basin is in itself a very interesting region which has given rise even in Australia to many hypotheses on the origin of the continent. The salty ingredients of the soil, the salt water lakes, and the sea-shore-like plains west of the Torrens Basin described by Stuart, were used as arguments for the supposition that this part of Australia had been lifted out of the sea in a comparatively recent period only; that in its place an arm of the sea formerly existed, which perhaps connected Spencer's Gulf with the Gulf of Carpentaria, whereby Australia was divided into two parts. These hypotheses, though pleasantly drawn out, must however be considered useless and hasty, as by a close scientific physical examination they are as likely soon to be refuted as confirmed. Even Babbage's calculations of his barometrical observations are still wanting and with them the basis most necessary to a physical examination of the country. However, in relation to height, we may assume as tolerably certain, that from Spencer's Gulf in the direction from N. to N.W., plains extend into the interior elevated but little above the level of the sea and separated from each other by plateaux. The Torrens Basin with its lagoons and coast plains forms one of these low tracts, a second one is represented by that series of lakes, which commences with Lake Dutton and ends on the other side of Lake Younghusband in several swamps and sloughs; a third is formed by the great sinkings of Lake Gairdner and its environs. Major Warburton believes that Lake Gairdner is situated below the level of the sea. If this be true, it must also be the case with the Great Salt Lake and the other adjacent lakes,—as we find in Babbage's Reports no intimation of any difference in their height. Without expressing any definite opinion we will only mention, that Gregory, in his previous expedition from Moreton Bay to Adelaide, crossed the Torrens Basin and found by barometrical means that this basin was situated decidedly above the level of the sea. But the Torrens Basin has there, as the most recent travellers in Australia affirm, its greatest depth. Warburton's opinion therefore remains for the present at least improbable.

The area of the discovered lakes is not inconsiderable, as a comparison with the Lake of Constance shows (*Area* 207 Eng. or 9·75 Germ. sq. m.). By a calculation based on sketches of charts we find

Lake Gairdner in the extent given on the chart	2807 E.	or	132 G.	M.
Great Salt Lake,	351 "	"	16·5	"
Lake Hart,	140 "	"	6·6	"
Pernatty Lagoon,	85 "	"	4	"
Lake Younghusband,	57 "	"	2·7	"
Lake Windabout,	49 "	"	2·3	"
Lake Reynolds,	6·4 "	"	0·3	"

Besides the plateaus, which extend in a northerly direction between the Torrens Basin and that row of lakes situated west, and also between these and Lake Gairdner, elevated perhaps only a few hundred feet above the lakes and their low shores, we find frequently series of heights and isolated elevations. With the exception of the Gawler Mountains, 3000 Engl. feet high, they do not seem to be of any consequence, for Stuart asserts in his description of Mount Finke, that this mountain, though only equal to Mount Arden, was the highest he had seen in his travels.

Concerning the other physical conditions of the country, its vegetation, fauna, etc., we shall speak when giving a more detailed report of Stuart's voyage and the further explorations of Babbage and Warburton. We shall only add in this connection a few words on the practical results of the surveys. The best impressions are undoubtedly made by Hack's descriptions of the Gawler Mountains and the region bordering them on the north and east. There, without doubt, extensive tracts of land are found with a sufficient quantity of fresh water and fertile soil well adapted to stations for cattle and perhaps even agricultural purposes, having the advantage of being easily accessible from the coast, to which they lie near. South and west we find those fearful deserts which Eyre passed through, and where Stuart and Foster suffered from hunger. Farther east in the direction of Lake Torrens, the absence of permanent sweet water springs is the greatest impediment to colonization, for good pastures are neither wanting in the low lands along the lakes, nor even on the plateaus, though we find them here in more isolated tracts. The number of springs, however, and fresh water basins seems to increase considerably the nearer you approach the interior, as Stuart's and Babbage's accounts plainly show. Even Major Warburton, one of the Australian *pessimists*, could not but express his surprise at the great number of springs on the pastures discovered by him north of Stuart's Creek, although he sees almost everything in a more unfavorable light than the rest, and thinks a permanent settlement between Spencer's Gulf and Lake Campbell an impossibility. Several thousand square miles of pasture in such a seclusion and separated by girdles of shrubs and stony plains might really seem to be unworthy of notice, if the peculiar character of Australia were not to be taken into consideration. With an increase of 100,000 souls in its population, with its rapid development in raising cattle, the want of new grass-land is felt more severely than almost anywhere else upon the earth.

We shall but add in reference to this subject, that a week after Stephen Hack's return from the Gawler Mountains a price was offered for some 2000 miles of the 4500 English sq. miles of the new discovered pastures. Several cattle owners followed

Babbage's expedition almost upon his steps, and a Mr. Macdonald was about to make Wirrawirralu his permanent station. Swinden and Stuart reserved for their own use considerable tracts of land in those regions which they discovered. A possession of fertile and useful lands is considered advantageous even if hard of access, as on the west side of the Torrens Basin, where a communication with the coast requires considerable exertion and expense. An attempt is made to overcome the want of springs by artesian wells, for which, according to Babbage, the conditions are favorable. Enterprising colonists had commenced boring already last year at different places, as for instance on the northern foot of the Baxter Mountains.

A particular account of Stuart's bold journey of discovery, illustrating and confirming the results which have been stated above, is contained in the Berlin *Zeitschrift für allgemeine Erdkunde* for January, 1859.

Report of the Superintendent of the (United States) Coast Survey, showing the progress of the Survey during the year 1857. Wash., 1858, pp. 18 and 448, 4to, with 72 plates and charts.—This valuable volume, although bearing date of last year, has been distributed only within a few months. In the brief space at our command it is impossible to state in any detail the great amount and variety of important matter which Prof. Bache has in this report so clearly and ably exhibited. The report shows most fully that the Survey is conducted with eminent efficiency, and that the highest theoretical science and the best artistic skill are brought to bear on this great national work. The astronomical, magnetic, and tidal observations so extensively carried on by the officers of the survey, are, in addition to their direct importance, of great value to the general interests of science.

The appendix, which comprises pages 121—445 of the volume, is rich in valuable notices and papers. Among these may be specified those by the accomplished Superintendent, on the *Atlantic Coast Tides*, and on the *Winds of the Western Coast of North America*, the memoir by Lieut. E. B. Hunt on an *Index of Scientific References*, and the Report by Mr. J. G. Kohl on the *Western Coast Annals of Maritime Discovery and Exploration.*

Numerous charts, diagrams, and other illustrations accompany the volume, and it is well furnished with a table of contents and an alphabetical index, which are so essential to the usefulness of such a work.

We are happy to know that these Reports are distributed with a liberal hand, so that probably every person in the country who can make any use of it, can easily obtain a copy. It gives us pleasure to see also that our government supports the Survey with such enlightened liberality, for we are confident that the outlay yields a full return to the true interests of the nation.

KOHL'S REPORT TO THE U. S. COAST SURVEY ON THE HISTORY OF MARITIME DISCOVERY ON THE PACIFIC COAST OF THE U. STATES.—The Report of the Superintendent of the U. S. Coast Survey for 1857, just published, not only contains as usual important contributions to the hydrography and topography of this country, but many discussions of general interest. Having previously referred to Dr. Kohl's investigations on the coast of the Atlantic and Gulf of Mexico, we here call attention to an outline of his report on the Pacific coast, which is given in the appendix to the volume above referred to. His report begins with a general survey of the physical features of the western coast of the U. States, written from the point of view of the navigator, not the naturalist. To this succeeds a history of discoveries on the Pacific, in groups corresponding with the periods of Cortez, Drake, and Vancouver, whose maritime enterprise was particularly distinguished. By means of notes, full references are made both to the original reports of voyages and to the subsequent discussions of them. A special hydrography of the coast has also been prepared, and two appendixes are added, the first giving reduced copies of maps and charts, ancient and modern, the second a historical map showing the additions to our knowledge made by successive explorers.

We are confident that this work when given to the public will be received with great interest. Its plan is comprehensive and its importance obvious.

DR. M. WAGNER'S VISIT TO THE CORDILLERAS, ON THE GULF OF SAN BLAS.—We find in the *Zeitschrift für allgemeine Erdkunde* (Berlin, Jan. 1859) a Report of Dr. Moritz Wagner's in respect to an important and hitherto unknown part of the Cordilleras. This well-known traveller proposed to determine the following points. 1. Do the Cordilleras, between the Gulf of San Blas and the valley of the R. Chepo consist of one or more chains? 2. Is there, between 9° 1′ and 9° 20′ N. lat. and between 80° 50′ and 81° 30′, a depression in the mountain chain favorable for an interoceanic canal? 3. Is there between the sources of the Chepo and the rivers falling into the Atlantic, really as supposed a plateau, and how high is the same? 4. What is the geological formation of the Isthmus? He condenses the results of his observations in the following words:

1. The Cordilleras, between the Gulf of San Blas and the mouth of Rio Bayano (Chepo), form one central chain passing from east to west through the Isthmus.

2. The average height of this chain is 920 to 1000 Paris feet above the Pacific Ocean at the time of high tide. The highest point reached by Wagner is elevated 1141 feet. Farther north the summits ascend higher, 1800 to 2000 feet. El Generale is estimated not to exceed 2800 feet in height.

3. Another lower chain of mountains extends along the Atlantic coast; behind it the Gulf of San Blas is situated. A valley from three to four leagues in width is extended between both chains, which are now and then connected by transversal ridges. El Generale is such a transversal ridge; it stretches from south to north and divides at the north. The northern slope of the Cordilleras is everywhere steeper than the southern. In the valley many fine prairies are found, being separated from one another by low hills.

4. The valley of Mamoni forms a considerable depression in the Cordilleras, and cuts them, as it were, through. Our camp in the centre of this pass was only 293 feet above Chepo and 874 feet above the level of the Pacific Ocean. Up to this point of the passage the river has from its source a fall of about 120 feet. As to the Madroño nothing reliable could be elicited from the natives; it is however very probable that under this name that river is meant, which on Codazzi's chart is called Rio Mandingo, and which empties into the Gulf of San Blas.

5. Almost all the mountain crests and the northern slope of the Cordilleras consist of granite, which is also found in the beds of the rivers. A great portion of the top is covered with a kind of conglomerate, either of a yellow or red color, in proportion as the oxyd of iron preponderates. Something similar is seen at the summit of Cerro del Ancon near Panama.

It is very interesting to see how at the springs of Rio Chagres the Cordilleras suddenly cease to form a continuous chain, splitting, so to speak, in little round mountains, especially between Panama and Gatim. Here also the granite disappears, being replaced by porphyry, dolerite or trap.

No part of the Cordilleras between the Gulf of San Blas and the Rio Chepo gives any indication of the possibility of establishing an interoceanic canal. The most favorable situation for this purpose is still, in Wagner's opinion, the valley of the rivers Obispo and Rio Grande, viz. the present railroad route.

African Explorations.—Petermann's Mittheilungen, for February 1859, contains brief intelligence in respect to several of the African expeditions. We make the following extracts.

Burton and Speke, who have reached the inner African sea, report that there is not one sea only, but four. The one which they have visited they call the Ugidschi; the others, Tschiwa, Nyassa, and Ukerewa.

A letter from the missionary Rebmann has the following interesting remarks, under the date of Sept. 19, 1858. "A new traveller, Dr. A. Roscher, has arrived here. I said to him that I hoped he would first visit Kilimandjaro, that it might be settled whether I had taken white stone for snow, or not. This matter is to me of the highest interest. It seems to me that if it should prove stone the mountain would be so much the more

remarkable. The peak is so white that I could think it nothing but snow, and I was not a little surprised to hear from some learned men in Europe that it was thought to be anything else."

Dr. Baikie's Niger expedition has now been two years in progress without attaining any noteworthy results. The expedition lost its first steamboat on the rocks not far from Rabba. Meanwhile all the world had learned through Dr. Barth's fifth volume, that the great western branch of the Niger, leading to Timbuktoo, offered great difficulties to navigation. It is to be regretted that the other branch, the Benue, had not before been chosen for exploration. It is now proposed to direct attention to it. Baron Krafft, under the name of Hadj Skander, has set out to visit Timbuktoo. Extracts from his diary are promised in Petermann.

The nautical director of Dr. Livingstone's expedition, Captain Bedingfield, has unexpectedly returned to England on account of a disagreement with Dr. Livingstone.

A journey from Natal to the river Limpopo is projected by two of the missionaries. The lower and middle parts of this stream, which is probably after the Zambesi, the most important of East Africa, are as yet quite unknown.

ONDARZA'S NEW MAP OF BOLIVIA.—Under the authority of the government of Bolivia, a new map of that country has recently been engraved and printed at the office of Messrs. J. H. Colton & Co., New York.

It is based upon the explorations and surveys of Col. Ondarza, Commandant Mujia, and Major Camacho, the former of whom has been engaged in the work for seventeen years, and has lately been supervising in our country this publication of his results.

The chart (which is issued in four sheets), is almost exclusively limited to the territory of Bolivia itself, but the surveys have extended toward the south into the Argentine confederation. Marginal maps are given of the La Plata and Amazon, from the respective surveys of Page and Herndon, and plans of the cities La Paz and Sucre. The depth and rapidity of the principal rivers are stated at numerous points, and the localities in which are found gold, silver, copper, or other metals are also carefully indicated.

We are informed that in the course of the surveys the elevations of more than three thousand points have been barometrically determined, many of them by repeated observations. One of the determinations affords the means of a comparison between an instrumental leveling extending between 13,000 and about 17,000 feet, and the result of an extended series of barometric observations. The elevations of several of the principal mountains are restored by these observations to the figures originally ascribed to them but very much reduced by Pentland in

his map. This is the case with Sorata and Illimani. The elevations which have been ascertained, and further scientific observations will be given in a volume soon to be published on the geography, statistics, &c. of the country.

A statistical table appended to the map gives the population of Bolivia as follows for 1858:

Provinces.	Inhab.
La Paz,	475,822
Cochabamba,	319,892
Potosi,	281,229
Chuquisaca,	223,668
Oruro,	110,931
Santa Cauz,	153,164
Tarija,	88,900
Veni,	53,973
Atacama,	5,273
Savage tribes,	245,000
Total,	1,987,352

The map appears to have been executed with great care in its details, and is a very important contribution to the orography of South America. D. C. G.

Art. XII.—*Alexander von Humboldt.*

Alexander von Humboldt died at Berlin on Friday the sixth of May, having been ill with a severe catarrh accompanied by fever since the 17th of April.

Eulogy by Prof. Agassiz, *before the American Academy of Arts and Sciences, delivered on the 24th of May.*

Gentlemen:—I have been requested to present on this occasion some remarks upon the scientific career of Humboldt. So few days have elapsed since the sad news reached our shore, that I have had no time to prepare an elaborate account of that wonderful career, and I am not myself in a condition in which I could have done it, being deprived of the use of my eyes, so that I had to rely upon the hand of a friend to make a few memoranda on a slip of paper, which might enable me to present my thoughts in a somewhat regular order. But I have, since the day we heard of his death, recalled all my recollections of him; and, if you will permit me, I will present them to you as they are now vividly in my mind.

Humboldt—Alexander von Humboldt, as he always called himself, though he was christened with the names of Frederick Heinrich Alexander,—was born in 1769, on the 14th of Sep-

tember,—in that memorable year which gave to the world those philosophers, warriors and statesmen who have changed the face of science and the condition of affairs in our century. It was in that year that Cuvier also and Schiller were born; and among the warriors and statesmen, Napoleon, the Duke of Wellington and Canning are children of 1769, and it is certainly a year of which we can say that its children revolutionized the world.

Of the early life of Humboldt I know nothing, and I find no records except that in his tenth year he lost his father, who had been a Major in the army during the seven years' war, and afterwards a chamberlain to the King of Prussia. But his mother took excellent care of him, and watched over his early education. The influence she had upon his life is evident from the fact that notwithstanding his yearning for the sight of foreign lands he did not begin to make active preparations for his travels during her life time. In the winter of 1787–'88 he was sent to the University of Frankfort on the Oder, to study finance. He was to be a statesman; he was to enter high offices, for which there was a fair chance, owing to his noble birth and the patronage he could expect at the Court. He remained, however, but a short time there.

Not finding those studies to his taste, after a semestre's residence in the University we find him again at Berlin, and there in intimate friendship with Willdenow, then Professor of Botany, and who at that time possessed the greatest herbarium in existence. Botany was the first branch of natural science to which Humboldt paid especial attention. The next year he went to Göttingen,—being then a youth of twenty years; and here he studied natural history with Blumenbach; and thus had an opportunity of seeing the progress zoology was making in anticipation of the great movement by which Cuvier placed zoology on a new foundation. For it is an unquestionable fact that in first presenting a classification of the animal kingdom based upon a knowledge of its structure, Blumenbach in a measure anticipated Cuvier; though it is only by an exaggeration of what Blumenbach did that an unfair writer of later times has attempted to deprive Cuvier of the glory of having accomplished this object upon the broadest possible basis. From Göttingen he visited the Rhine, for the purpose of studying geology, and in particular the basaltic formations of the Seven Mountains. At Mayence he became acquainted with George Forster, who proposed to accompany him on a journey to England. You may imagine what an impression the conversation of that active, impetuous powerful man made upon the youthful Humboldt. They went to Belgium and to Holland, and thence to England, where Forster introduced him to Sir Joseph Banks. Thus the companions of Capt. Cook in his first and second voyages round the world,

who already venerable in years and eminent as promoters of physical science not yet established in the popular favor, were the early guides of Humboldt in his aspirations for scientific distinction. Yet Humboldt had a worldly career to accomplish. He was to be a statesman, and this required that he should go to the Academy of Commerce at Hamburg. He remained there five months, but he could endure it no longer, and he begged so hard that his mother allowed him to go to Freyberg and study Geology with Werner, with a view of obtaining a situation in the Administration of Mines. See what combinations of circumstances prepare him for his great career, as no other young man ever was prepared. At Freyberg he received the private instruction of Werner, the founder of Modern Geology, and he had as his fellow student no less a man than Leopold von Buch, then a youth, to whom, at a later period, Humboldt himself dedicated one of his works, inscribing it "to the greatest geologist," as he was till the day of his recent death. From Freyberg he made frequent excursions to the Hartz and Fitchtelgeberg and surrounding regions, and these excursions ended in the publication of a small work upon the Subterranean Flora of Freiberg, (Flora Subterranea Fribergensis), in which he described especially those Cryptogamous plants, or singular low and imperfect formations which occur in the deep mines. But here ends his period of pupilage.

In 1792 he was appointed an officer of the mines (Oberbergmeister.) He went to Beyreuth as Director of the operations in those mines belonging to the Frankish Provinces of Prussia. Yet he was always wandering in every direction, seeking for information and new subjects of study. He visited Vienna, and there heard of the discoveries of Galvani, with which he made himself familiar; went to Italy and Switzerland, where he became acquainted with the then celebrated Professors Jurine and Pictet, and with the illustrious Scarpa. He also went to Jena, formed an intimate acquaintance with Schiller and Goethe, and and also with Loder, with whom he studied anatomy. From that time he began to make investigations of his own, and these investigations were in a line which he has seldom approached since, being experiments in physiology. He turned his attention to the newly discovered power by which he tested the activity of organic substances; and it is plain, from his manner of treating the subject, that he leaned to the idea that the chemical process going on in the living body of animals furnished a clue to the phenomena of life, if it was not life itself. This may be inferred from the title of the book published in 1797—"*Über die gereizte Muskel und Nerven-faser, mit Vermuthungen über den chemischen Process des Lebens, in Thieren und Pflanzen.*" In these explanations of the phenomena we have the sources of the first

impulses in a direction which has been so beneficial in advancing the true explanation of the secondary phenomena of life; but which, at the same time, in its exaggeration as it prevails now has degenerated into the materialism of modern investigators. In that period of all-embracing activity, he began to study Astronomy. His attention was called to it by Baron von Zach, who was a prominent astronomer, and at that time was actively engaged upon astronomical investigations in Germany. He showed Humboldt to what extent astronomy would be useful for him, in his travels, in determining the positions of places, the altitude of mountains, &c.

So prepared Humboldt now broods over his plans of foreign travel. He has published his work on the muscular and nervous fibre at the age of 28. He has lost his mother; and his mind is now inflamed with an ungovernable passion for the sight of foreign and especially tropical lands. He goes to Paris to make preparation by securing the best astronomical, meteorological and surveying instruments. Evidently he does not care where he shall go, for on a proposition of Lord Bristol to visit Egypt he agrees to it. The war prevents the execution of this plan, and he enters into negotiations to accompany the projected expedition of Capt. Baudin to Australia; but when Bonaparte, bent on the conquest of Egypt, started with a scientific expedition, Humboldt wishes to join it. He expects to be one of the scientific party, and to reach Egypt by way of Barbary. But all these plans failing, he goes to Spain with the view of exploring that country, and finding perhaps some means of joining the French expedition in Egypt from Spain. While in Madrid he is so well received at the Court—a young nobleman so well instructed has access everywhere—and he receives such encouragement from persons in high positions, that he turns his thoughts to an exploration of the Spanish provinces of America. He receives permission not only to visit them, but instructions are given to the officers of the colonies to receive him everywhere and give him all facilities, to permit him to transport his instruments, to make astronomical and other observations, and to collect whatever he chooses; and all that only in consequence of the good impression he has made when he appeared there, with no other recommendation than that of a friend who happened to be at that time Danish Minister to the Court of Madrid. With these facilities offered to him, he sails in June, 1799, from Corunna, whence he reaches Teneriffe, makes short explorations of that island, ascending the peak, and sailing straightway to America, where he lands in Cumana, in the month of July, and employs the first year and a half in the exploration of the basin of the Orinoco and its connection with the Amazon. This was a journey of itself, and completed a work of scientific import-

ance, establishing the fact that the two rivers were connected by an uninterrupted course of water. He established for the first time the fact that there was an extensive low plain, connected by water, which circled the high table land of Guiana. It was an important discovery in physical geography, because it changed the ideas about water courses and about the distribution of mountains and plains in a manner which has had the most extensive influence upon the progress of physical geography. It may well be said that after this exploration of the Orinoco, physical geography begins to appear as a part of science. From Cumana he makes a short excursion to Havana, and hearing there of the probable arrival of Baudin on the West coast of America, starts with the intention of crossing at Panama. He arrives at Carthagena, but was prevented by the advance of the season from crossing the Isthmus, and changed his determination from want of precise information respecting Baudin's expedition. He determines to ascend the Magdalena river and visit Santa Fé de Bogôta, where, for several months, he explores the construction of the mountains, and collects plants and animals; and, in connection with his friend, Bonpland, who accompanied him from Paris, he makes those immense botanical collections, which were afterwards published by Bonpland himself, and by Kunth after Bonpland had determined on an expedition to South America. In the beginning of 1802 he reaches Quito, where, during four months, he turns his attention to every thing worth investigating, ascends the Chimborazo, to a height to which no human foot had reached, anywhere; and, having completed this survey and repeatedly crossed the Andes, he descends the southern slope of the continent to the shore of the Pacific at Truxillo, and following the arid coast of Peru, he visits finally Lima. I will pass lightly over all the details of his journey, for they are only incidents in that laborious exploration of the country which is best appreciated by a consideration of the works which were published in consequence of the immense accumulation of materials gathered during those explorations. From Lima, or rather from Callao, he sails in 1802 for Guayaquil and Acapulco, and reaches Mexico in 1803, where he makes as extensive explorations as he had made in Venezuela and the Andes, and after a stay of about a year, having put all his collections and manuscripts in order, revisits Cuba for a short time, comes to the United States, makes a hurried excursion to Philadelphia and Washington, where he is welcomed by Jefferson, and finally returns with his faithful companion Bonpland to France, accompanied by a young Spanish nobleman, Don Carlo de Montufar, who had shared his travels since his visit to Quito.

At thirty-six years of age Humboldt is again in Europe with collections made in foreign lands, such as had never been brought

together before. But here we meet with a singular circumstance. The German nobleman, the friend of the Prussian and Spanish Courts, chooses Paris for his residence, and remains there twenty-two years to work out the result of his scientific labor; for since his return, with the exception of short journeys to Italy, England and Germany, sometimes accompanying the King of Prussia, sometimes alone, or accompanied by scientific friends, he is entirely occupied in scientific labors and studies. So passes the time to the year 1827, and no doubt he was induced to make this choice of a residence by the extraordinary concourse of distinguished men in all branches of science with whom he thought he could best discuss the results of his own observations. I shall presently have something to say about the works he completed during that most laborious period of his life. I will only add now, that in 1827 he returned to Berlin permanently, having been urged of late by the King of Prussia again and again to return to his native land. And there he delivered a series of lectures preparatory to the publication of Cosmos; for in substance, even in form and arrangement, these lectures, of which the papers of the day gave short accounts, are a sort of prologue to the Cosmos, and a preparation for its publication.

In 1829, when he was 60 years of age, he undertakes another great journey. He accepts the invitation of the Emperor Nicholas to visit the Ural Mountains, with a view of examining the gold mines and localities where platina and diamonds had been found, to determine their geological relations. He accomplished the journey with Ehrenberg and Gustavus Rose, who published the result of their mineralogical and geological survey in a work of which Rose is the sole author; while Humboldt published under the title of Asiatic Fragments of Geology and Climatology, his observations of the physical and geographical features made during that journey. But he had hardly returned to Berlin, when in consequence of the revolution of 1830, he was sent by the King of Prussia as extraordinary ambassador to France, to honor the elevation of Louis Philippe to the throne. Humboldt had long been a personal friend of the Orleans family, and he was selected as ambassador on that occasion on account of these personal relations. From 1830 to 1848 he lived alternately in Berlin and in Paris, spending nearly half the time in Paris and half the time in Berlin, with occasional visits to England and Denmark; publishing the results of his investigations in Asia, making original investigations upon various things, and especially pressing the establishment of magnetic observatories, and connected observations all over the globe, for which he obtained the co-operation of the Russian government and that of the government of England; and at that time those observatories in Australia and in the Russian Empire to the borders of

China, were established which have led to such important results in our knowledge of terrestrial magnetism. Since 1848 he has lived uninterruptedly in Berlin, where he published on the anniversary of his 80th year a new edition of those charming first flowers of his pen, his Views of Nature, the first edition of which was published in Germany in 1808. This third edition appeared with a series of new and remodeled annotations and explanations; and that book in which he first presented his views of nature, in which he drew those vivid pictures of the physiognomy of plants and of their geographical distribution, is now revived and brought to the present state of science. The "Views of Nature" is a work which Humboldt has always cherished, and to which in his Cosmos he refers more frequently than to any other work. It is no doubt because there he had expressed his deepest thoughts, his most impressive views, and even foreshadowed those intimate convictions which he never expressed, but which he desired to record in such a manner that those that can read between the line might find them there; and certainly there we find them. His aspiration has been to present to the world a picture of the physical world from which he would exclude everything that relates to the turmoil of human society, and to the ambitions of individual men.

A life so full, so rich, is worth considering in every respect, and it is really instructive to see with what devotion he pursues his work. As long as he is a student he is really a student and learns faithfully, and learns everything he can reach. And he continues so for twenty-three years. He is not one of those who is impatient to show that he has something in him, and with premature impatience utters his ideas, so that they become insuperable barriers to his independent progress in later life. Slowly and confident of his sure progress, he advances, and while he learns he studies also independently of those who teach him. He makes his experiments and to make them with more independence he seeks for an official position. During five years he is a business man, in a station which gives him leisure. He is Superintendent of the Mines, but a Superintendent of the Mines who can do much as he pleases; and while he is thus officially engaged journeying and superintending, he prepares himself for his independent researches. And yet it will be seen he is thirty years of age before he enters upon his American travels, those travels which will be said to have been the greatest undertaking ever carried to a successful issue, if judged by the results; they have as completely changed the basis of physical science as the revolution which took place in France about the same time has changed the social condition of that land. Having returned from these travels to Paris, there begins in his life a period of concentrated critical studies. He works up his materials then

with an ardor and devotion which is untiring; and he is not anxious to appear to have done it all himself. Oltmanns is called to his aid to revise his astronomical observations, and his barometrical measurements by which he has determined the geographical position of 700 different points and the altitude of more than 450 of them.

The large collection of plants which Bonpland had begun to illustrate, but of which his desire of seeing the tropics again has prevented the completion he entrusts to Kunth. He has also brought home animals of different classes, and distributes them among the most eminent zoologists of the day. To Cuvier he entrusts the investigation of that remarkable Batrachian, the Acsolotel,—the mode of development of which is still unknown, but which remains in its adult state in a condition similar to that of the tadpole of the frog during the earlier period of its life. Latreille describes the insects, and Valenciennes the shells and the fishes; but yet to show that he might have done the work himself, he publishes a memoir on the anatomical structure of the organs of breathing in the animals he has preserved, and another upon the tropical monkeys of America, and another upon the electric properties of the electric eel. But he was chiefly occupied with investigations in physical geography and climatology. The first work upon that subject is a dissertation on the geographical distribution of plants, published in 1817. Many botanists and travellers had observed that in different parts of the world there are plants not found in others, and that there is a certain arrangement in that distribution; but Humboldt was the first to see that this distribution is connected with the temperature of the air as well as with the altitudes of the surface on which they grow, and he systematized his researches into a general exposition of the laws by which the distribution of plants is regulated. Connected with this subject he made those extensive investigations into the mean temperature of a large number of places on the surface of the globe, which led to the drawing of those isothermal lines so important in their influence in shaping physical geography and giving accuracy to the mode of representing natural phenomena. Before Humboldt we had no graphic representation of complex natural phenomena which made them easily comprehensible, even to minds of moderate cultivation. He has done that in a way which has circulated information more extensively, and brought it to the apprehension more clearly than it could have been done by any other means.

It is not too much to say, that this mode of representing natural phenomena has made it possible to introduce in our most elementary works, the broad generalizations derived from the investigations of Humboldt in South America; and that every

child in our schools has his mind fed from the labors of Humboldt's brain, wherever geography is no longer taught in the old routine. Having completed his American labors, Humboldt published three works partly connected with his investigations in America, and partly with his further studies in Europe since his return, and among others, a book, which first appeared as a paper in the "Dictionnaire des Sciences Naturelles," but of which separate copies were printed under the title of "Essai sur la Constitution des Roches dans les deux Hemisphères." This work has been noticed to the extent which it deserved by only one geologist, Elie de Beaumont. No other seems to have seen what there is in that paper, for there Humboldt shows, for the first time, that while inorganic nature is the same all the world over,—granite is granite, and basalt is basalt, and limestone and sandstone, limestone and sandstone wherever found,—there is everywhere a difference in the organized world, so that the distribution of animals and plants represents the most diversified aspects in different countries. This at once explains to us why physical sciences may make such rapid progress in new countries, while botany and zoology have to go through a long process of preparation before they can become popular in regions but recently brought under the beneficial influence of civilization. For while we need no books of our own upon astronomy, chemistry, physics and mineralogy, we have to grope in the dark while studying our plants and animals until the most common ones become as familiar to us as the common animals of the fields in the old countries. The distinction which exists in the material basis of scientific culture in different parts of the world is first made evident by this work. By two happily chosen words Humboldt has presented at once the results of our knowledge in geology at the time, in a most remarkable manner. He speaks there of "independent formations." Who, before Humboldt, thought there were successive periods in the history of our globe which were independent one from the other? There was in the mind of geologists only a former and a present world. Those words expressing the thought and expressing it in reference to the thing itself, for the first time occur in that memoir; thus putting an end to those views prevailing in geology, according to which the age of all the rocks upon the earth can be determined by the mineralogical character of the rocks appearing at the surface. The different geological levels at which rocks belonging to the same period have been deposited, but which have been disturbed by subsequent revolutions, he happily designated as "geological horizons."

It was about the time he was tracing these investigations that he made his attempt to determine the mean altitude of the continents above the sea. Thus far geographers and geologists had

considered only the heights of mountain chains, and the elevation of the lower lands, while it was Humboldt who first made the distinction between mountain chains and table lands. But the idea of estimating the average elevation of continents above the sea had not yet been entertained; and it was again Humboldt, who, from the data that he could command, determined it to be at the utmost 900 feet, assuming all irregularities to be brought to a uniform level. His Asiatic travels gave him additional data to consider these depressions and swellings of continents, when discussing the phenomena of the depressions of the Caspian Sea, which he does in a most complete manner.

There is a fullness and richness of expression and substantial power in his writing, which is most remarkable, but which renders his style somewhat involved. He has aimed to present to others what nature presented to him,—combinations interlocked in such a complicated way as hardly to be distinguishable, and his writings present something of the kind. You see his works, page after page, running into volumes without division into chapters or heads of any sort; and so conspicuous is that peculiarity of style in his composition, that I well remember hearing Arago turning to him, while speaking of composition, and saying, "Humboldt, you don't know how to write a book—you write without end, but that is not a book; it is a picture without frame." Such an expression of one scientific man to another, without giving offense, could only come from a man so intimately associated as Arago was with Humboldt. And this leads me to a few additional remarks upon his character and social relations. Humboldt was born near the Court. He was brought up in connection with courtiers and men in high positions of life. He was no doubt imbued with the prejudices of his caste. He was a nobleman of high descent. And yet the friend of kings was a bosom friend of Arago, and he was the man who could, after his return from America, refuse the highest position at the court of Berlin, that of the secretaryship of public instruction, preferring to live in a modest way in Paris, in the society of all those illustrious men who then made Paris the centre of intellectual culture. It was there where he became one of that Societé d'Arcueil, composed of all the great men of the day, to which the paper on "Isothermal Lines" was presented, and by which it was printed, as all papers presented to it were, for private distribution. But from his intimate relations especially to the court of Prussia, some insinuations have been made as to the character of Humboldt. They are as unjust as they are severe in expression. He was never a flatterer of those in power. He has shown it by taking a prominent position, in 1848, at the head of those who accompanied the victims of the revolution of that year to

their last place of rest. But while he expressed his independence in such a manner, he had the kindliest feelings for all parties. He could not offend, even by an expression, those with whom he has been associated in early life; and I have no doubt that it is to that kindliness of feeling we must ascribe his somewhat indiscriminate patronage of aspirants in science, as well as men who were truly devoted to its highest aims. He may be said to have been, especially in his latter years, the friend of every cultivated man, wishing to lose no opportunity to do all the good of which he was capable; for he had a degree of benevolence and generosity which was unbounded. I can well say that there is not a man engaged in scientific investigation in Europe, who has not received at his hands marked tokens of his favor, and who is not under deep obligations to him. May I be permited to tell a circumstance which is personal to me in that respect, and which shows what he was capable of doing while he was forbiding an opportunity of telling it. I was only 24 years of age when in Paris, whither I had gone with means given to me by a friend; but was at last about to resign my studies from want of ability to meet my expenses. Professor Mitscherlich was then on a visit in Paris, and I had seen him in the morning, when he had asked me what was the cause of my depressed feelings; I told him that I had to go for I had nothing left. The next morning as I was seated at breakfast in front of the yard of the hotel where I lived, I saw the servant of Humboldt approach. He handed me a note, saying there was no answer and disappeared. I opened the note, and I see it now before me as distinctly as if I held the paper in my hand. It said:

"My friend, I hear that you intend leaving Paris in consequence of some embarrassment. That shall not be. I wish you to remain here as long as the object for which you came is not accomplished. I enclose you a check for £50. It is a loan which you may repay when you can."

Some years afterwards when I could have repaid him I wrote, asking for the privilege of remaining forever in his debt, knowing that this request would be more consonant to his feelings than the recovery of the money, and I am now in his debt. What he has done for me, I know he has done for many others; in silence and unknown to the world. I wish I could go on to state something more of his character, his conversational powers, &c., but I feel that I am not in a condition to speak of them. I would only say that his habits were very peculiar. He was an early riser, and yet he was seen at late hours in the saloons in different parts of Paris. From the year 1830 to 1848, while in Paris, he had been charged by the King of Prussia to send reports upon the condition of things there. He had before prepared for the King of Prussia a report on the political condition of the

Spanish Colonies in America, which no doubt had its influence afterwards upon the recognition of the independence of those colonies. The importance of such reports to the government of Prussia may be inferred from a perusal of his political and statistical essays upon Mexico and Cuba. It is a circumstance worth noticing that above all great powers Prussia has more distinguished, scientific and literary men among her diplomatists than any other State. And so was Humboldt actually a diplomatist in Paris though he was placed in that position, not from choice, but in consequence of the benevolence of the King, who wanted to give him an opportunity of being in Paris as often and as long as he chose.

But from that time there were two men in him,—the diplomatist, living in the Hotel des Princes, and the naturalist who roomed in the Rue de la Harpe, in a modest apartment in the second story; where his scientific friends had access to him every day before seven. After that he was frequently seen working in the library of the Institute until the time when the Grand Seigneur made his appearance at the court or in the saloons of Paris.

The influence he has exerted upon the progress of science is incalculable. I need only allude to the fact that the Cosmos, bringing every branch of natural science down to the comprehension of every class of students has been translated into the language of every civilized nation of the world, and gone through several editions. With him ends a great period in the history of science, a period to which Cuvier, Laplace, Arago, Gay-Lussac, Decandolle and Robert Brown belonged, and of whom only one is still living,—the venerable Biot.

ART. XIII.—*On the origin of Vibrio;* by H. JAMES CLARK of Cambridge, Mass.

(From the Proceedings of the American Academy, Boston, April 12, 1859.)

A FEW months ago a French physiologist, Pouchet, revived the long-exploded doctrine of equivocal or spontaneous generation, and asserted that he had been able to obtain certain living beings from substances which were entirely shut off from the outer world, and in which, after having undergone certain preparations, there could not possibly be any germs of these animals. A discovery, which I made on the 20th of March, may not be uninteresting, as it has more or less relations in its nature to the theory so earnestly advocated by Pouchet. There are certain well known bodies described as animals by Ehrenberg, under the name of Vibrio; their peculiarity consists in that they are

composed of a single row of globular bodies, resembling a string of beads, more or less curved, and move in a spiral path with great velocity, even faster than the eye can follow in many cases. They exhibit, by their activity, more plausible signs of animality than any of the Desmideæ or Diatomaceæ, and fully as convincing indications of life as the spores of Algæ, to which they were first referred by the late lamented Dr. W. I. Burnet, and after him by Rudolph Wagner and Leuckart. They have always been spoken of as developing around decaying animal and vegetable matter. I was very much surprised to discover the manner in which they orginate from such substances. I was studying the decomposing muscle of a Sagitta, a little crustacean, as I consider it,—which, in passing, I would observe was found by me a year ago last March, for the first time in this country, at Lynn Harbor,—when I noticed large numbers of Vibrio darting hither and thither, but most frequently swarming about the muscular fibres. I was struck with the similarity of these bead-like strings to the fibrillæ of the muscle, and upon close comparison I found that the former were exactly of the same size, and had the same optical properties as the latter. Some of these appeared to be attached to the ends of the flat, ribbon-like fibres, and others at times loosened themselves and swam away. I was immediately impressed with the daring thought, that these Vibrios were the fibrillæ set loose from the fibres; but as this was a thing unheard of, and so startling, I for the time persuaded myself that they must have been accidentally attached and subsequently loosened. However, I continued my observation until I found some fibres in which the fibrillæ were in all stages of decomposition. At one end of the fibre the ultimate cellules of the fibrillæ were so closely united, that only the longitudinal and transverse striæ were visible; further along, the cellules were singly visible, and still further they had assumed a globular shape; next, the transverse rows were loosened from each other excepting at one end; and finally, those at the extreme of the fibre were agitated and waved to and fro as if to get loose, which they did from time to time, and, assuming a curved form, revolved each upon its axis and swam away with amazing velocity. There was no doubting, after this, the identity of the Vibrios and the muscular fibrillæ; but I thought such a strange phenomenon ought to have a second witness to vouch for it, and therefore went for the best that could be wished for, Professor Agassiz. I simply placed the preparations before him, and, without giving him the least hint of the origin of the muscle, I was pleased to have him rediscover what I had seen but fifteen minutes before.

The number of ultimate cellules in a moving string varied from two to fifty; the greatest number of strings were composed

of only three or four, often six to eight, and rarely as high as fifty. Very rarely the fibres split longitudinally, and in such instances the fibrillæ were most frequently long, and moved about with undulations rather than a wriggling motion. A single ultimate cellule, when set loose, danced about in a zigzag manner; but whenever two were combined, the motion had a definite direction, which corresponded to the longer diameter of the duplicate combination; and if only three were combined, the spiral motion was the result of their united action. What it is that causes these cellules to move I do not profess to know, but certainly it is not because they possess life as independent beings. This much is settled, however, that we may have presented to us all the phenomena of life, as exhibited by the activity of the lowest forms of animals and plants, by the ultimate cellules of the decomposed and fetid striated muscle of a Sagitta. I do not pretend to say that everything that comes under the name of Vibrio or Spirillum is a decomposed muscle or other tissue, although I believe such will turn out to be the fact; but this much I will vouch for, and will call on Professor Agassiz to witness, that what would be declared, by competent authority, to be a living being, and accounted a certain species of Vibrio, is nothing but absolutely dead muscle.

ART. XIV.—*Biographical Sketch of Professor Denison Olmsted;* by Rev. C. S. LYMAN.

IT is with deep sadness that we record the death of Professor DENISON OLMSTED, for thirty-four years the honored incumbent of the chair of Natural Philosophy and Astronomy in Yale College. He died at his residence in New Haven, after a few weeks illness, on the 13th of May, 1859, in the sixty-eighth year of his age.

Besides this brief record, it is fitting that this Journal, to which Professor Olmsted has been a contributor from its commencement, should preserve, as a further tribute to his memory, such a sketch as our limits will permit of his career as a man of science. For a full analysis of his life and character in the several relations, public and private, which he was called to fill, we neither have room, nor is this the appropriate place. And such a presentation, we are happy to add, is rendered the more unnecessary by the very complete and admirable commemorative Address of Pres. Woolsey,* in which is given a just and discriminating estimate not only of Prof. Olmsted's scientific

* New Englander for August, 1859.

labors, but, more fully, of his successful career as an instructor, and of his well-balanced and exemplary character as a man and a christian in all the relations of life. It will be our purpose, therefore, in this sketch, to contemplate Prof. Olmsted, chiefly, as a teacher and cultivater of science.

He was born in East Hartford on the 18th of June, 1791,—the fourth child of Nathaniel Olmsted, a respectable farmer, who was a descendant of James Olmsted, one of the first settlers of the colony of Connecticut. His mother, a daughter of Denison Kingsbury of Andover, Ct., was a woman of most exemplary christian character, and to her (his father having died when he was about a year old) he was indebted for that excellent religious training, the fruits of which were exhibited in all his subsequent life, and for which she found herself rewarded, even to extreme old age, by a depth of affection and veneration on his part such as few mothers can inspire.

In Farmington, to which town his mother removed, on her second marriage, when he was about nine years old, he attended a district school for several winters, having his home for that purpose in the family of Gov. Treadwell. This excellent man, becoming interested in the boy for his amiability, intelligence, and other promising traits, took pains to instruct him privately during the long evenings, especially in arithmetic, which was not then taught in the common schools; and so befriended him, in this and other ways, that in after life Prof. Olmsted ever cherished his memory with the deepest affection and gratitude, and at a later period, embodied his estimate of his benefactor in an elaborate memoir, published in the American Quarterly Register for 1843.

At the age of sixteen, when he had been for some time employed in a country store, in which a son of Gov. Treadwell was one of the partners, he made up his mind to obtain a liberal education; and after pursuing his preparatory studies, first at an excellent school kept by James Morris at Litchfield South Farms, and afterwards under Rev. Noah Porter, pastor at that time, as now, of the church in Farmington, he entered Yale College in 1809, when Dr. Dwight, to whom he afterwards became strongly attached, and who exerted a very decided influence on his character, was in the zenith of his reputation and power. Young Olmsted was a diligent and successful scholar, and at his graduation in 1813, took the rank of an orator in a class of seventy, when only ten received that honor.

On leaving college, Mr. Olmsted became a teacher in New London, taking charge of the "Union School," so called,—a private institution for boys. In 1815 he was appointed to a tutorship in Yale College, and while filling this office, commenced the study of theology in a class instructed by Dr. Dwight, with

a view to entering the ministry. In about a year, however, his revered instructor was removed by death, and Mr. Olmsted evinced his affection for his memory by an appreciative memoir, which was published in the Port Folio for November, 1817. Meanwhile his experience and observation as a teacher, not only in college and in New London, but in Farmington also, where, at the age of seventeen, he taught a district school, appear to have awakened in his mind a deep interest in the subject of education, and a desire to make some effort for the improvement of the schools of his native state. In an oration "on the state of education in Connecticut," which he delivered in 1816 on taking his Master's degree, he sketched the outlines of a plan, original with himself, of what he termed a "seminary for schoolmasters," to be supported by the State;—an idea since so happily realized in our Normal Schools.

But his aims in this direction were terminated, as well as his theological studies, by his appointment in 1817 to the chair of Chemistry in the University of North Carolina, upon the duties of which he entered after a year spent at New Haven in special preparation under the private instruction of Prof. Silliman. At Chapel Hill he not only discharged successfully the duties of his professorship, (which, besides chemistry, then included, as in most other colleges, mineralogy and geology,) but, during his residence there, he was also employed by the State to make a survey of its geology and mineral resources;—a circumstance the more worthy of notice, as this was the first enterprize of the sort accomplished under the auspices and at the expense of any of the States. The project was first laid by Prof. Olmsted, in 1821, before the Board of Internal Improvements, with the offer to perform the entire work himself, gratuitously, and the modest suggestion of an appropriation by the Board of "*one hundred dollars,* to be afterwards renewed or not at the pleasure of the Board," to defray his necessary expenses in traveling. This proposition, however, the Board declined, and the survey was afterwards made under the direction of the State Board of Agriculture. To this Board Prof. Olmsted addressed his Report, which was published in two parts, in 1824 and 1825, filling in all about 140 pages octavo; so unpretending was the prototype of the numerous and ponderous volumes of scientific research which have since been published by so many of the States. This survey, regarded especially as the gratuitous vacation-work of a single individual, and in view of the state of geological science in this country at the time, must certainly be looked upon as creditable in the highest degree both to the enterprise and the scientific ability of its projector; and it has undoubtedly been of great benefit, not only to the State which authorized it, but to the country and to science generally, by the stimulus which

it afforded to similar enterprises in other States. Prof. Olmsted gave the first geological description of the Deep River Coal Field, and of the Red Sandstone accompanying; and referred the strata correctly to the same age with that of the Richmond coal beds and the Connecticut River Sandstone.

While at Chapel Hill, Prof. Olmsted also began researches to determine the practicability of obtaining illuminating gas from cotton-seed—a waste material so abundant in cotton-growing districts as to be an important product of agriculture if capable of being put to any valuable use.

These researches, however, were broken off, as well as his further cultivation of chemistry and geology, by his call, in 1825, to the professorship of Mathematics and Natural Philosophy in Yale College, left vacant by the death of Prof. Matthew R. Dutton, who himself, only three years before, had succeeded the lamented Fisher, Prof. Olmsted's classmate and intimate friend, whose brief but brilliant mathematical career was so sadly terminated by shipwreck in 1822, when on his way to Europe for the purpose of study.

Prof. Olmsted came to this new chair, it will be noticed, after he had spent some of his best years in one requiring attainments and mental culture of a widely different cast. But though lacking somewhat, as he was himself aware, in that special preparation which a devotion of those years to the higher mathematics and the more abstruse investigation of physics might have given him, he nevertheless applied himself with such zeal to his new duties as to overcome in great measure the difficulties he encountered, and approve himself a successful instructor in the branches committed to his care. The department of mathematics, however, in accordance with his own wishes, was in 1835 made a separate chair, and assigned to the able and promising, but short-lived Prof. Anthony D. Stanley, while Prof. Olmsted retained his favorite branches of natural philosophy and astronomy. In these he continued to give instruction down to his last illness, a period in all of thirty-four years.

When he came to New Haven he discovered a sad want of suitable text-books in his department. Enfield's Philosophy, which had held its place in our colleges for many years, was full of inaccuracies and far behind the existing state of science. And the series of text-books then recently prepared by Prof. Farrar of Cambridge, chiefly translations from French authors, were, besides other objections, both too extensive and too difficult for the majority of American students at that period. This recognized want Prof. Olmsted successfully met by the preparation of his larger work on Natural Philosophy, which was first published in 1831, in two volumes octavo. This work, though in parts professedly a compilation or abridgment, as in mechanics,

from the treatise of Bridge, and though excluding the higher mathematics, which were not then taught in our colleges, is yet characterized by so many excellencies of form and arrangement, and on the whole is so well adapted to the wants of the great majority of students, that it has from the first been received with favor by the public, and having passed through many editions, continues to be very extensively used in the colleges of the United States. If the rapid progress of research and discovery since its first publication has rendered some changes necessary to adapt it to the present state of science and to the higher standard of education in our colleges, a new and thorough revision of the whole work, which its author was about to enter upon at the time of his death in connection with Prof. Snell of Amherst and Prof. Newton of Yale College, and which, it is understood, these gentlemen are now carrying forward, will be likely to render it as acceptable hereafter as it proved to be when originally published.

An abridgment of this work, called the "School Philosophy," was published in 1832, for the use of high schools and academies, and has already, it is said, passed through more than a hundred editions. A still smaller work, entitled "Rudiments of Natural Philosophy and Astronomy," was issued in 1842, and is adapted to pupils in elementary schools. This little work has gone through some fifty editions, and on account of its clearness and comprehensiveness, has been adopted as the text-book on these subjects for use in institutions for the blind, an edition for this purpose having been printed in raised letters, in large quarto form, as early as 1845.

Prof. Olmsted's text-book of Astronomy for colleges was published in 1839 in one volume octavo. It is characterized, in the main, by the same qualities as his other books, and has found general favor, it is believed, among the teachers of that science. An abridgment for schools was published soon after the original work. Still another book on the same science, called "Letters on Astronomy," purporting to have been written to a lady, was prepared by Prof. Olmsted as a reading book at the request of the Massachusetts Board of Education, and published in 1842.

Besides instructing in astronomy by text-book, Prof. Olmsted delivered annually to the two upper classes in college three courses of lectures, one on natural philosophy and optics, one on astronomy, and another on meteorology. These he prepared with much labor, and by frequent revision, endeavored to adapt to the rapid progress of scientific discovery. They were characterized by fullness, clearness and method, and sometimes by eloquence. The course on meteorology was, perhaps, on the whole, the most attractive and useful.

In the subjects of storms, auroras, and shooting-stars, he took special interest. A new theory of Hail-storms was published

by him, in 1830, in the American Journal of Science,—ascribing their origin to the sudden mingling of large bodies of hot and humid air with air extremely cold, by which the vapor of the former would be rapidly condensed and congealed into hail; which effect would be produced whenever, by means of opposing winds, whirlwinds, or other atmospheric disturbance, hot air should be carried above the line of congelation or cold air brought below it. This hypothesis, though it has never obtained the celebrity of the ingenious, but improbable, electrical theory of Volta, is yet, perhaps, as plausible as any, or at least is sufficiently so to warrant its author in his steady adherence to it, especially if we consider that such is the intrinsic difficulty of the subject as to compel the acutest physicists to confess that no satisfactory theory has yet been proposed,—hailstorms being characterized by Pouillet as among the most formidable of scourges to agriculture, and the most perplexing of phenomena to meteorologists.

In respect to the great storms of our Atlantic coast, and similar ones elsewhere, he adopted in the main, the rotary theory of Mr. Wm. C. Redfield, whom he early encouraged in the development of his views on this subject, and for whom he cherished a sincere attachment, which led him, after the death of his friend, to prepare the eulogium which he delivered before the American Association for the Advancement of Science, at its meeting in Montreal. In this address Prof. Olmsted thus defines his own position in respect to Mr. Redfield's views. "While from the first I have heartily embraced Redfield's doctrine that ocean gales are progressive whirlwinds, and have further fully believed that he had established their laws or modes of action on an impregnable basis, a regard to truth and candor obliges me to say, that I have never been a convert to his views respecting the ultimate causes of storms, especially so far as he assigned for these causes what he denominates the 'diurnal and orbitual motions of the earth,' but his notions on this point have always appeared to me unsatisfactory."

The phenomena of the northern lights, such remarkable exhibitions of which occurred in 1835 and 1837, were watched by Prof. Olmsted with intense interest, and one of his latest and most elaborate memoirs is that "On the Secular Period of the Aurora Borealis," published in 1856, in the eighth volume of the Smithsonian Contributions. In this paper, rejecting the electrical and magnetic hypotheses, and others which ascribe the origin of the aurora to terrestrial causes, he advocated the doctrine of their cosmical origin, deriving their materials from some supposed nebulous body traversing the planetary spaces, and assigning to the phenomena a secular period of about sixty or sixty-five years. This view, it must be acknowledged, has

found, as yet, little favor among men of science. But, whether it prove ultimately to have any foundation in truth or not, Prof. Olmsted deserves very great credit for the unwearied diligence with which he has collected and recorded the facts, and for the earnestness with which he has called the attention of philosophers to this most interesting problem in physics.

But Prof. Olmsted is most widely and favorably known to the scientific world by his papers, published chiefly in the Journal of Science for 1834, on "meteoric showers," or showers of shooting stars. His interest in the subject was first awakened, like that of many others, by the very remarkable phenomena of the morning of November 13th, 1833, when, in all parts of the United States, myriads of these meteors, especially between the hours of two and five o'clock, were seen falling in a brilliant and continuous shower through the heavens. Prof. Olmsted saw this magnificent display, indeed, not in its maximum grandeur, but only the portion of it which occurred after half past five o'clock, when his attention was first called to it by a friend. Yet observing it with the eye of a philosopher, he noted with care its most important features, and collecting at once all the observations he could obtain from various quarters, he made a careful classification and analysis of the facts, which he presented in two successive numbers of the American Journal of Science for 1834.* While preparing this paper he was led to entertain the idea that these meteors had a cosmical rather than a terrestrial or atmospheric origin, and at the close of his article, stated it as his general conclusion, "That the meteors of Nov. 13th consisted of portions of the extreme parts of a nebulous body, which revolves around the sun in an orbit interior to that of the earth, but little inclined to the plane of the ecliptic, having its aphelion near to the earth's path, and having a periodic time of 182 days, nearly."

Prof. A. C. Twining, then at West Point, from his own and other independent observations, arrived substantially at some of the same conclusions, especially in respect to the cosmical origin of the meteors, though apparently with a less degree of confidence, as appears from his own candid remark in his very able article on the subject in the twenty-sixth volume of the Journal of Science, "That he is not able, as yet, to adopt even his own inferences respecting the cause, in any other way than as *conjectural and highly credible.*" Both he and Prof. Olmsted, however, clearly recognized the leading fact, which was decisive of the question of cosmical origin, namely, the identity of the point of apparent radiation of the meteors with the point in the heavens towards which the earth was then moving in its orbit, and the names of both must consequently be associated, in the minds of those who read their articles, with the theory which both so essentially contributed to establish.

* Vol. xxv, No. 2, and Vol. xxvi, No. 1.

Prof. Olmsted, however, has from the first been chiefly associated in the public mind with this theory of meteors,—partly, perhaps, from the greater confidence and fullness of explanation with which he propounded it, and partly from his prominent position before the public in an important chair of science. The theory, indeed, in the precise form in which he originally stated it, has never in all its details obtained general currency, and was even for a time wholly rejected or regarded with much incredulity by many distinguished men of science, yet in its leading features of cosmical origin and periodicity he had the satisfaction of seeing it remain unshaken, and receive the approbation and support of the leading physicists of the day. A broader generalization of facts, especially those gathered by Mr. E. C. Herrick, from the records of meteors in preceding ages, soon brought to light other annual periods of their return besides that of November, particularly those of April, August and December. This modification, however, did not affect the main point of the hypothesis.

It has been said, indeed, that Prof. Olmsted was anticipated in this theory by Chladni; and Humboldt, who in several passages of the Cosmos, speaks of the researches of Prof. Olmsted in complimentary terms, refers to them in one place, not as having originated the hypothesis, but as "a brilliant confirmation of the cosmical origin of these phenomena,"* ascribing to Chladni the credit of the theory itself. But besides the fact that, so far as appears, the cosmical hypothesis of Chladni pertained especially to aerolites and their associated fireballs, and did not definitely include showers of shooting stars, and the further fact, that the idea of the cosmical origin of this whole class of meteors had been suggested in general terms by many other philosophers even including Anaxagoras, we may remark, without claiming for Prof. Olmsted the merit of priority, that his conclusions were unquestionably original with himself, and entirely independent of any results of preceding investigations. Whatever form in respect to its details, the theory may assume in the light of future researches, to Prof. Olmsted clearly belongs the merit of having discerned and demonstrated its leading truth, and he deserves for what he has done, all the credit that has been accorded to him by European savans. Humboldt, Biot, Olbers, Encke, and others, adopting substantially the same views, have fully recognized his merits and spoken of his investigations in complimentary terms.

Prof. Olmsted gave much attention also to the subject of the zodiacal light, and in papers published in the Journal of Science and in the Proceedings of the American Association, has endeavored to establish an identity between its source and that of the November meteors. The same idea has received the sanction

* Cosmos, vol. i, p. 118, Harper.

and support, also, of M. Biot, who assigns to Prof. Olmsted the credit of its authorship.

It will be seen, from the brief account we have given, that Prof. Olmsted was inclined to adopt theories very similar to each other, to explain the phenomena of shooting stars, of auroras, and of the zodiacal light—if not, indeed, to ascribe them all to one and the same origin. But if, in the case of auroras or the zodiacal light, his speculations shall fail to be confirmed, it must be remembered that they were for the most part thrown out by him only as conjectures, and that he himself disclaimed holding his theory of meteors at all responsible for their soundness; and furthermore, that it is a thing by no means of rare occurrence among men of science that a successful theorizer has been tempted by success to stretch the application of his theory beyond its legitimate limits.

The want of a proper observatory and of suitable instruments at New Haven, prevented Prof. Olmsted from giving to practical astronomy as much attention as he might otherwise have done. Of the Clark telescope, however, at that time the best in the country, he made as good use as his other engagements and the wretched position of the instrument would allow, in showing to his pupils such celestial phenomena as admitted of simple inspection; and with this instrument in 1835, he, with Prof. Elias Loomis, then a tutor in the College, succeeded first of American observers in obtaining a view of Halley's comet, then so anxiously looked for both in this country and in Europe. This deficiency of astronomical instruments Prof. Olmsted was always anxious to remove, and at various times efforts were commenced, in which he zealously participated, to establish an observatory. But many difficulties arose from time to time, especially in the matter of raising funds, and he never enjoyed the satisfaction of seeing so desirable an object accomplished.

In teaching science, Prof. Olmsted by no means restricted himself to theoretical instruction, but, both in the lecture-room and in popular articles and addresses, endeavored to render science attractive and useful to all, by pointing out its practical applications. He gave much attention to the means of protecting houses from lightning, the warming and ventilation of buildings, and other like practical problems, as they were brought to his notice, frequently contributing articles on such topics to the papers of the day, and often, on the occurrence of any special phenomena coming within the range of his department of science, favoring the public with an appropriate discourse. He was the inventor of an excellent stove which bore his name, the patent for which became to him at first, it is understood, a source of some pecuniary profit, at a time when his insufficient salary rendered an increase of income particularly acceptable, but afterwards, from

causes not connected with its merits, ceased to be remunerative. A useful preparation of lard and rosin for lubricating machinery was also invented by him some years ago, but never patented, and it has since, it is said, become an article of successful manufacture.

In forming our estimate, on the whole, of Prof. Olmsted's scientific character, we must bear in mind that he himself always regarded it as his more appropriate sphere of effort, in the circumstances in which he was placed, not so much to *cultivate* science as to *teach* and *diffuse* it. Teaching, indeed, was his chosen and ever-cherished work, and the one for which by temperament, talents, training and attainments, he was peculiarly fitted. His uniform kindness and courtesy of demeanor, and patience in imparting instruction—the excellent moral influence which he always exerted as well by his consistent christian example as by his personal counsels—the genuine friendliness of his disposition, and the unaffected interest which he always manifested in the welfare of his pupils—especially the readiness and fidelity with which he encouraged and assisted any who exhibited special fondness for the studies of his department—will not soon be forgotten by those who enjoyed the benefit of his instructions, and especially by those who were admitted to his closer friendship. Ebenezer Porter Mason was a pupil whose brilliant and versatile talents, and especially his rare attainments and promise in mathematics and astronomy, awakened in his instructor at once the liveliest and most affectionate interest; and on the death of this remarkable genius at the early age of twenty-two, Prof. Olmsted paid a tribute not less to his own kindness of heart than to the memory of his friend, in writing the excellent memoir of his life which was published in a duodecimo volume in 1842.

Besides the writings which have been named, Prof. Olmsted published, at different times, many elaborate articles of a scientific or literary character, in the leading periodicals of the day, particularly the American Journal of Science and the New Englander. He was especially fond of biographical composition, and his memoirs of Dr. Dwight, Sir Humphry Davy, Gov. Treadwell, Eli Whitney and Wm. C. Redfield, may be mentioned as favorable examples.

In the later years of his life, Prof. Olmsted saw much affliction. Besides his first wife, four sons, grown to manhood, graduates of college, and giving fine promise of usefulness and distinction in literature or science, were one after another taken from him,—filling his home with grief yet not destroying his cheerfulness or composure of mind. But he has now gone to his rest, and not alone his remaining family, but the wide circle of his friends and former pupils will cherish with deep affection his honored memory.

ART. XV.—*Correspondence of Prof. Jerome Nicklès of Nancy, France, dated April 17th*, 1859.

Academy of Sciences.—Distribution of Prizes.—On the 14th of last March the Academy of Sciences held its annual public meeting. We have more than once spoken of these annual sessions and shown them to be generally void of result, a fact for which the Academy itself, which accomplishes so poorly its mission, is to blame. It has been this year as in preceding years, and we are compelled to repeat the truth: if we were to judge of the progress of science by the prizes awarded, we should infer that nothing new had been accomplished in the departments of mathematics, mechanics, physics, chemistry, geology, mineralogy, botany, &c.,—we could almost say in all departments of experimental science. Happily it is not so, and our readers have been able to judge by our correspondence for the years 1857 and 1858, that in Europe as in America, men of science have well employed their time and their strength to the great advantage of science and humanity.

Astronomical Prize.—The only section which every year awards a prize, is that of astronomy, in behalf of which the astronomer Lalande established a fund for the purpose of granting a medal to the person who in France, or elsewhere (the members of the Institute excepted), should have made the most important observation or prepared a treatise or work contributing most highly to the progress of the science. Not willing to pronounce on this latter point, the Academy has divided the prize between MM. Goldschmidt of Paris, Laurent of Nismes, Searle of the Observatory at Albany, N. Y., Tuttle of Cambridge, Mass., Winnecke of Bonn, and Donati of Florence. The following is an extract from the report.

The planet Nemausa was discovered on the 22d of January at Nismes by Mr. Laurent, and the planet Pandora on the 10th of September by Mr. George Searle, assistant in the Observatory at Albany in America. The names of these two savans are now inscribed for the first time in the list of observers who, within a dozen years, have enriched astronomy by discoveries of asteroids.

The planet Calypso, discovered on the 4th of April at the observatory of Bilk by Mr. Luther, is the seventh the knowledge of which is due to this skilful astronomer.

The two planets, Europa and Alexandra, were discovered at Paris the 4th of February, and the 10th of September by Mr. Goldschmidt, that successful explorer of the skies, who, without having to meet the ordinary responsibilities of an astronomer, devotes himself continually, through love for science, to the most laborious researches. It was at first thought that he had rediscovered, on the 9th of September, 1857, the planet Daphne; but Mr. Schubert of Berlin soon showed this to be a mistake, proving that the planet was a new one. This planet, which by the date of its discovery is the 47th of the group, increases to *twelve* the number made known by Mr. Goldschmidt.

Among the comets of the year 1858, there are two whose periodicity is well established, and one that presented during its long and brilliant

display phenomena of great interest bearing on the physical theory of comets.

Of the three comets discovered at Cambridge in America by Mr. Tuttle, the first on the 4th of January, the third on the 2d of May, and the sixth on the 5th of September, the first is of peculiar interest, as its elements are recognized as identical with those of the second comet of 1790 discovered by Méchain. Mr. Bruhns of Berlin, who discovered this comet seven days after Mr. Tuttle, has compared a great number of observations made up to the month of March in Europe and in America, and has deduced from them an elliptical orbit of 13·66 years. The comet discovered on the 4th of January by Mr. Tuttle has therefore returned four times since 1790 without having been seen.

Statistical Prize.—Of a number of prizes for statistics we notice an "honorable mention" decreed to Mr. Bérigny of Versailles for a work on the question, "Is there any connection between germination and the changes of the moon, or between its phases and human generation?" This statistical treatise contains a list of 30,958 births according to the civil state-registers of Versailles, and extending over forty years. The results are negative; that is to say, on the authority of the civil register of Versailles it can be declared that the moon does not possess, like the sun, the privilege of influencing the march of human generations.

Prize for Experimental Physiology.—The great prize for Experimental Physiology was awarded to Mr. Jacubowitch for his treatise on the *Internal structure of the brain, and on the spinal cord of man and animals.* According to the statement of the commission this work contains results of great importance to histology, physiology, and comparative anatomy. The report made by Mr. Claude Bernard concludes thus. "In recapitulation, Mr. Jacubowitch has taken up one of the most difficult problems in physiology and anatomy, that of the texture of the nervous system and of the different constituent elements with reference to determining their physiological importance. This author has recognized and described three peculiar forms of nervous cellules in their relations to one another and to three kinds of nervous fibres. He has determined the exact arrangement of these nervous histological elements in the spinal cord, the medulla oblongata, and the brain; he has indicated the points of the nervous centres in which these cellules or fibres group themselves, accumulate, mingle, separate, appear or disappear. These anatomical researches, made not only in man but also in four classes of vertebrate animals, are of great importance to physiology."

A second prize for Experimental Physiology was divided between Mr. Leuhossek of Warsaw and Mr. Lacaze-Duthiers, Professor in the faculty of sciences at Lille; the first for his "Etudes Anatomiques" on the central nervous system. These are researches in microscopic anatomy having numerous relations to physiology. The method employed by Mr. Leuhossek in his researches is the method of slices in different directions; the parts of the nervous system were not hardened by chromic acid, but only by alcohol, and the slices were rendered transparent either by acetic acid or some other convenient substance.

The labors of Mr. Lacaze-Duthiers have contributed largely to the progress of most of the branches in the history of acephalous mollusks;

the commission has bestowed its attention principally on the experiments and observations of this naturalist relating 1st, to the circulation of the nourishing fluids in the Dentalia; 2d, to the developments of the respiratory apparatus in mussels (Mytili); and 3d, to the structure of the urinary glands and the organs of generation of a considerable number of other mollusks.

The Bréant Prize.—We have already several times spoken of the prize of 100,000 francs instituted by Mr. Bréant in favor of the person who should discover a mode of medical treatment which would cure the cholera in the majority of cases, or who should point out satisfactorily the causes of Asiatic cholera so that by removing these causes, an end would be put to the epidemic; or lastly, to the person who should discover a certain preventive of it, as evident, for example, as that of vaccination for small-pox.

Foreseeing that this prize of 100,000 fr. would not be awarded very soon, Mr. Bréant grants the interest of this sum to the person who shall have promoted the progress of science as regards the cholera or any other epidemic malady.

This year the Academy of Sciences awarded a prize of 5000 fr. to Léon Doyère for his experiments on the composition of the air expired by victims of the cholera, and the temperature of the body of these patients during the last moments of life. Mr. Doyère has proved the following points: 1st, the more severe the attack of cholera, the larger the amount of oxygen in the air expired; 2d, the proportion of carbonic acid thrown out by cholera patients is very inconsiderable; 3d, notwithstanding the diminution of the activity of the respiratory functions, the temperature of the body increases till it reaches the point of 43° C. (110° F.) in the region of the armpit.

It is but justice to state that of these three results, the first was announced in 1832 by Mr. Rayer; the last was proved in 1830 by the French physicians who went into Poland to study the cholera; and it was afterwards verified in England and in the United States.

Moreover neither the second nor the third facts are peculiar to the victims of cholera. As for the second, Dr. Malcolm demonstrated in 1844, that in typhus fever a less quantity of carbonic acid escapes from the lungs than in the normal state of the body, and furthermore, Mr. Doyère has observed the same fact in respect to persons affected with typhoid fever and with acute pneumonia. As far as concerns the latter fact, many authors have noticed a rise of temperature in the last stages of scarlet and yellow fever, as in cases of cholera, and Mr. Doyère has seen the same thing in typhoid fever.

Discussion upon the nature of simple bodies.—The discussion mentioned in our last communication, and which was started by a paper read by Mr. Despretz, has since been renewed, and it has been watched with the utmost interest by all who are engaged in the physical sciences. Doubtless it has not changed the opinion of either Despretz or Dumas; and this is well for the latter chemist at least, for all competent observers regard Dumas as representing in this case the cause of progress.

While the discussion has been useless in this—that it has only brought out ideas which have been current in science, and in the elaboration of

which Dumas has had so large a share, it has had an important scientific bearing, since it has contributed to the establishment of these very ideas, and has compelled Dumas to put in a precise form his scientific opinions on the unity of matter and the intimate nature of simple bodies.

We give a brief notice of the discussion, as it is one which will without doubt leave its trace on the records of science.

Dumas having declared that the experiments which Despretz had just published were neither necessary in the actual state of science, nor yet decisive, Despretz replied in his turn, criticizing the ideas of Dumas on the unity of matter. According to him there is not a sufficient analogy between the radicals of organic chemistry and the simple bodies of mineral chemistry. The first are decomposed by heat, and converted by oxygen into water and carbonic acid. These organic compounds thus disunited can never be again re-composed. It is well understood to be quite otherwise in respect to the elements of mineral chemistry. From this Mr. Despretz concluded that there is not only no analogy, but that there is a complete contrariety, between the elements of organic and inorganic chemistry; in a word, as far as he can discern, science furnishes no indication favoring a belief in the decomposition of the bodies considered simple, even by the aid of new forces. On the contrary he thinks he has demonstrated that the metals and metalloids are simple bodies. We have already seen by what processes he thinks he has arrived at this conclusion: he returns to the subject now to show in what respect his experiments are new, and says: "all chemists have ignited iron and platinum to a white heat, but no chemist to our knowledge has ignited these metals in a barometric vacuum for the purpose of ascertaining whether any gas was disengaged; and this is my experiment."

"Nothing is disengaged under the action of heat, or of a spark from a powerful induction apparatus. This negative result is of a nature to astonish the partisans of the theory of Dr. Prout, if any exist. According to this hypothesis, iron should retain about 80,000 and platinum 200,000 volumes of hydrogen gas condensed into only one volume. How can we suppose that a condensed gas could resist the test to which iron and platinum are subjected in my experiment? Is there a single fact in physics and in chemistry which authorizes such a supposition? In my process the disengagement of $\frac{1}{20}$th of a cubic centimetre of gas would have been readily appreciable. To this slight weight the most delicate chemical balances would have been insensible."

The reply of Dumas is briefly as follows: "I demand of Mr. Despretz why he expects the metals to resolve themselves into gas? why is it necessary that the primary elements of bodies should be gaseous? As regards the analogies between organic and inorganic chemistry, which are denied by Mr. Despretz, I ask where is the chemist who would not unite in one group cyanogen and chlorine, bromine and iodine? Where are the differences between these two sets of substances? Do they not blend in all their chemical affinities? Does not the analogy between them extend even to a similarity of atomic volumes? It is true cyanogen has been decomposed while the others have resisted decomposition; but he is greatly mistaken who believes that the discovery of cyanogen did not suggest doubts to the minds of chemists, and to Gay Lussac himself, on the nature of chlorine."

"Is not the same the case with ammonium and the radicals of the ethers? Do not these radicals furnish oxyds, chlorids, sulphurets? Do not their oxyds, acting the part of bases, resemble potassa and soda so strongly as even to mislead? Have we not in the combinations of these radicals the same system as in inorganic chemistry? Who is the chemist to whom these discoveries succeeding one upon another, have not suggested doubts concerning the nature of the metals?"

"In a word, the efforts of modern chemists for forty years, efforts without parallel from the first beginning of chemistry as a science, in which so much perseverance and so much courage have been expended, have resulted in proving that organic chemistry is made up of substances which are subject to the very same laws with which Lavoisier enchained inorganic chemistry, and subordinated to the same scheme through all its products." It was Lavoisier who, on tracing out the route for us to follow, more than seventy years since, defined organic chemistry as the chemistry of *compound radicals*, and mineral chemistry the chemistry of undecomposable radicals."

Dumas then refuted one after another the facts brought forward by his antagonist in proof of his view. "If Mr. Despretz thinks that by distilling mercury, zinc, or cadmium, these substances can be decomposed, he forgets that alchemists and the arts long ago threw light on this point. If he confounds with the decomposition of a simple body the analysis of a mixture, I regret it, but I remain convinced that there is not the slightest connection between the successive separations and the decomposition of simple bodies; that there is nothing in common between those fortunate concentrations to which we owe the discovery of iodine, cadmium, selenium and bromine, and a philosophical discussion concerning the principle of the unity of matter."

Dumas presented the following conclusions: "1st. It appears to me more and more probable that the equivalents of simple bodies are multiples of the same unit; 2d, that the radicals of mineral chemistry behave in the same way as the radicals of organic chemistry; 3d, that it is impossible to prove that bodies reputed simple are undecomposable; 4th, that if, even at the present time, simply by employing forces and means already known, it is easy to contrive processes more powerful than those which Mr. Despretz has employed for the purpose of accomplishing this decomposition, I regard it as my duty to affirm anew that in my opinion these processes, though more rational, will not probably be more effectual."

Discussion on cellulose and ligneous fibre.—While this discussion on the question of simple bodies, of which we have spoken, was being carried on, and that concerning spontaneous generation so spiritedly agitated even to this present hour (see our last communication), another important question was handled before the Academy of Sciences; it was concerning the probability of the existence of only one, or of several kinds, of cellulose. Payen was an advocate of the first opinion, Fremy of the second. Judging from the action produced upon ligneous tissues by Schweitzer's reagent (see our last communication but one), Fremy admits at least two species of cellulose, for he has seen paper and textile fibres in general dissolve in ammoniacal oxyd of copper, while elder-pith and ligneous fibre in general resist its action.

To Mr. Payen this difference seemed only an apparent one; he believed that in this latter case, the cellulose is incrusted with gum and foreign matters which hinder the solubility; also the pith of the elder which is insoluble in Schweitzer's reagent, becomes soluble in it when it has been previously treated with a weak acid such as dilute chlorohydric acid. Mr. Fremy supposed that the chlorohydric acid does not act as a solvent of foreign matters, but that it converts one variety of cellulose into the other variety, in the same way, for instance, as an acid converts cane sugar into glucose.

We need not speak of the different phases of this discussion, for it is not yet settled. According to Fremy, we must admit at least two kinds of cellulose offering the same percentage composition but differing from each other in their chemical properties and capable of being brought into the same state by the most diverse reagents, such as mineral acids, organic acids, potassa, ammonia, etc. In order to prove that the differences in the properties of cellulose are due to the state of the organic substance itself and not to the presence of mineral substances, Fremy has had recourse to the action of heat. In exposing vegetable pith, which is insoluble in the cupreous reagent, to the action of a temperature not exceeding 30°, and maintaining it at that point for several hours, he has seen that substance become soluble in the above reagent. He arrived at an analogous result by keeping the cellular tissue of pith for twenty-four hours in boiling water.

Furthermore, he has remarked that this change takes place only in the organic substance of the tissue, for the proportion of mineral matter remained the same in both cases, and the tissue which had become soluble in the cupreous reagent, left after its calcination a mineral network, reproducing exactly the form of the vegetable cellules, which same thing happens to tissues not modified by either dry or humid heat.

In order to distinguish between these two kinds of cellulose, Fremy calls *para-cellulose* that which *does not dissolve immediately* in the cupreous reagent. He reserves the name cellulose for that which *dissolves directly without previous treatment*. *Cellulose* is found in cotton, fibres of bark, cellular tissue of fruits or of roots. *Para-cellulose* constitutes principally the pith of trees, ligneous fibre, the cellular tissue of the epidermis, &c.

This is not Payen's opinion; the experiment of Fremy, quoted above, does not appear to him to prove that the pith of the elder is of an isomeric composition with the cellulose of textile fibres; for in Payen's view it is not only the fact that foreign substances in the form of incrustations oppose the solution of the cellulose in Schweitzer's reagents, but infinitely minute bubbles of air which are condensed there have the same effect to a certain point, in forming a protective envelop; according to him the pith of the Æschynomene, insoluble in Schweitzer's reagent, becomes soluble in it by keeping it in a vacuum in the cold under an exhausted receiver and afterwards plunging it under water; the liquid is then placed in a refrigerating mixture. After congealing, the pith has become to a great extent soluble; there remains a residue of 43 per cent containing 15 per cent of mineral substances. These mineral substances according to Payen prevent the complete solution of the cellulose. The

same is the case with cortical fibres before their purification; so also hemp just obtained from the flax-plant resisted solution for more than six hours, and the portions not dissolved preserved their fibrous form.

Incrusting matter; Dead cotton.—All these questions have recalled attention to an old paper by Mitscherlich on the composition of vegetable cellules, cellules essentially formed of cellulose, and of a substance analogous to cork, a suberic material capable of yielding suberic acid and also succinic and nitric acids. The most delicate vegetable fibres are covered over with this slender coating of suberic matter; it is on this account that fresh cotton is with difficulty moistened with water, while it is at once decomposed if this coating of suberic matter is removed by the action of chlorine.

Such at least is the opinion of Mitscherlich. It seems however that an immersion in chlorine is not always sufficient to render this variety of cotton capable of receiving color,—the variety perfectly well known among dyers, who have named it "dead cotton;" it was first described by Daniel Koechlin of Mulhouse, and has since been carefully studied by Walter Crum of Glasgow, whose results are published in the third volume of the Proceedings of the Philosophical Society of Glasgow.

In the opinion of Mr. Walter Crum the dyeing of cotton depends upon a purely mechanical action; chemistry is completely foreign to the subject of fixing dyes upon stuffs; dead cotton is the proof of this; the fibres of this variety of cotton are flattened, while cotton which admits of being dyed is composed of cylindrical fibres; the coloring matter hence can penetrate within these and fix itself there.

This is, as is seen, an opinion diametrically opposite to that of Runge, who is so strong an advocate of the chemical theory that he considers colored cottons as *cottonates;* in this view a faint chamois tint produced by oxyds of iron is called by him *per-cottonate* of iron; another *bi-cottonate;* another still *basic cottonate* of iron.

Mr. Walter Crum declares that the substance of dead cotton has been entirely bleached before becoming flattened; it contains therefore, he says, neither fatty matter nor any impurity capable of hindering the fixing of the coloring matter.

But let us return to the suberic matter whose presence Mitscherlich recognized on leaves and about the exterior of plants. It is over thirty years since Payen showed that the epidermis of plants is covered over with a very thin envelop, containing a fatty matter, some nitrogen and silica. Ad. Brongniart has isolated this pellicle, on which Mitscherlich experimented, by submitting leaves to a prolonged maceration, and has described it under the name of cuticle; and Frémy, who has also just examined it, has recognized in it all the characteristics of a fatty substance which he calls *cutine.* In fact, in contact with boiling potassa, the cutine saponifies and the acid which is produced presents the characters of a fatty acid. This experiment has been repeated with success on the epidermic membranes of leaves, flowers and fruits.

It is easy to develop, ad libitum, this epidermic membrane; it is sufficient, in fact, to experiment on superficial sections of living tissues of leaves, branches, tuberaceous roots, and subterranean stems; at the end of several days the denuded tissues afford characteristic reactions of epidermic membranes.

Transformation of woody fibre into Sugar.—On the occasion of the above discussion Pelouze announced the important results which follow. Cellulose precipitated from its solution in ammoniacal oxyd of copper by a feeble acid, is soluble in dilute chlorohydric acid. Ordinary cellulose is soluble in concentrated chlorohydric acid; water forms with this solution a precipitate of dazzling whiteness; at the end of two days the precipitate ceases to form, and all the cellulose has been transformed into sugar affording the characteristics of glucose.

The transformation of cellulose into glucose can be effected by a prolonged ebullition in water containing a small quantity of sulphuric or chlorohydric acid (some hundredths); paper, old linen, sawdust, and any cellulose more or less pure, can be thus turned into sugar at the end of several hours boiling.

Pelouze thinks that this reaction will become the basis of a new branch of industry—one which has often been attempted since Braconnot succeeded in 1819 in transforming lignine into glucose; he thinks that the transformation would be rendered much more active by operating in a close vessel at an elevated temperature.

Lastly, Pelouze announces that, by treating cellulose with caustic potassa in fusion at a temperature between 150° and 190° C. and dissolving the product in water, a substance can be separated from it by acids which has the composition of cellulose, but differs from it in that it is soluble in the cold in alkalies; it changes into sugar in the presence of chlorohydric acid.

Manufacture of Aluminium.—This manufacture, which is becoming more and more extended, has just taken two steps onward; one, through the publication by H. St. Claire Deville, of a treatise expressly on the subject; the other, by the discovery of a process of soldering. All the labors expended on aluminium up to the month of March, 1859, are recounted by Deville, and as the author and founder of this manufacture, we can feel very certain that the work is not a simple compilation.

As respects the soldering of this metal, until very lately quite imperfect results have been attained. In the Universal Exhibition of 1855, there were pieces of aluminium soldered with zinc or with tin, but this weak solder did not give any solidity. Others have tried to solder with alloys of zinc, silver and aluminium. Mr. Denis of Nancy has noticed that whenever aluminium and the solder melted over its surface was touched with a slip of zinc, the adhesion took place with great rapidity as if a peculiar electric action gave it an impulse at the moment of contact; but this solder also has failed to afford much strength.

At last it has been suggested that the difficulty might be surmounted by previously coating the piece with copper, and then soldering together the coppered surfaces. In order to effect this, the aluminium, or at least the parts to be soldered, are plunged into a bath of acid sulphate of copper. The positive pole of the battery is put in direct communication with the bath, and the pieces to be coppered are touched with the negative pole; the deposit of copper takes place very regularly over the surface of the aluminium. These surfaces thus prepared are soldered in the ordinary way.

All these processes are, as is seen, very imperfect, and they now have only a historical interest, on account of a new and perfect method of

soldering just discovered. The inventor is a gilder and silverer of metals, belonging to Paris, named Mourey; he has recently announced his process in a public meeting of the Société d'Encouragement. The alloy employed is composed of zinc and aluminium; Mr. Mourey employs five different varieties of it according to the article to be soldered; the composition is as follows:

	I.	II.	III.	IV.	V.
Zinc,	80	85	88	92	94
Aluminium,	20	15	12	8	6

To prepare it, he melts the aluminium in a crucible of graphite, the metal having been reduced to fragments and added little by little; when the mass is in fusion it is stirred with an iron rod while the zinc is added in small quantities at a time; the alloy is still stirred while a little tallow is added to prevent the oxydation of the zinc, and then it is cast in small ingots. It is important to avoid too high a temperature lest the zinc should be volatilized. It is also important that the zinc should be free from iron.

These five alloys have different points of fusion. Alloy No. 1 is the hardest, the others are softer in regular succession.

As for the manipulation of the solder, this comes under technology: Mr. Mourey has described it in detail; but it would be going too much into specialities for us to cite his account of it, and we subjoin only a few facts interesting in a scientific point of view.

The instrument which is used in the soldering, and which is called in French "fer-a-souder," ought not in soldering aluminium to be either of iron or copper, but of aluminium itself; for the soldering alloy adheres to iron or copper in preference to aluminium. The flux used to facilitate the adhesion is made of three parts balsam of copaiba, mixed with one part of pure turpentine; the materials are mixed in a porcelain capsule, and a few drops of lemon-juice are added to favor the mixture of the two resins.

This flux is used for thoroughly impregnating the fragments of solder which are to be employed. It is important to use the blowpipe no longer than is necessary, to prevent loss of zinc from volatilization.

Lastly, another novelty of this branch of manufacture is aluminium bronze, which has the proportion of ten parts of aluminium to ninety of copper, and has the tenacity of steel. This alloy is now applied on a large scale by J. M. Christoffle; he has noticed that it is of great advantage to make all the surfaces of friction in machinery of aluminium-bronze. Thus a bearing which had been placed on a polishing lathe making 2200 revolutions a minute was found to last eighteen months, while bearings of other different metal, had, in the same circumstances, lasted at most only three months. He has employed this bronze with equal success in the manufacture of cannon, howitzers, and all kinds of weapons of war. Pistol-barrels have been thus made which have done good service.

There is as yet nothing very conclusive with regard to this application to artillery; but Mr. Christoffle, relying on the tenacity of aluminium-bronze and its resistance to wear, thinks that it will be applicable to the manufacture of bronze for cannons. As in France large artillery-pieces are constructed exclusively in the government work-shops, he has asked for a permit to manufacture at his own expense some pieces of artillery, especially such as are most exposed to injury.

ART. XVI.—*Seventh Supplement to Dana's Mineralogy;* by the Author.

List of Works, etc.

FR. VON KOBELL: Die Mineralogie. 248 pp. 12mo, with 4 plates. Leipzig, 1858. An excellent mineralogical manual.

Dr. T. SCHEERER: Löthrohrbuch.—A manual on the blowpipe and blowpipe analysis. 294 pp. 12mo. Braunschweig, 1857.

Dr. A. KENNGOTT: Uebersicht der Resultate mineralogischer Forschungen in den Jahren 1856 und 1857. 272 pp. 8vo. Leipzig, 1859.—Dr. Kenngott is now professor of mineralogy at Zurich, and still finds time to continue his excellent review of the progress of Mineralogy. This volume covers the years 1856 and 1857.

Dr. A. KENNGOTT: Tabellarischer Leitfaden der Mineralogie. 272 pp. 8vo. Zurich, 1859.

Dr. J. SCHABUS: Anfangsgründe der Mineralogie. 250 pp. 8vo. Vienna, 1859.

DELAFOSSE: Nouveau cours de minéralogie, comprenant la description de toutes les espèces minérales avec leurs applications directes aux arts. Tome 1er, 1re et 2e livraisons. Paris, 1858. 8vo, 550 pp., with an Atlas of 16 pages and 20 plates.

DUFRENOY'S Mineralogy.—The 4th volume of the new edition has just been issued at Paris.

Dr. RITTER VON ZEPHAROVICH: Mineralogischen Lexicon für das Kaiserthum Oesterreich.—Mineralogical Lexicon for the Austrian empire. This work is mentioned in the Bulletin of the K. K. geol. Reichs. for 1858, p. 116.

G. SUCKOW: Die Mineralogie in besonderer Beziehung auf chemisch-genetische und metamorphische Verhältnisse der Mineralien. 8vo. 1858.

Dr. J. G. KURR: Album de Minéralogie; in 4to with 22 colored plates. Paris. Firmin Didot frères. 30 fr.—Also translated into English and republished in London.

L. GRUNER: Description géologique et minéralogique du département de la Loire. xx and 779 pp. 8vo, with 7 charts. Paris, 1858.

ROSSI: Nuovi principii Mineralogici. 64 pp. 4to. Venice, 1857.—According to a notice in Jahrb. Min. 1858, 75, the work presents a new classification of minerals, dividing them into 6 classes and their subordinate groups. The classes are, 1. EXOGENS, the gases and water; 2. ENDOGENS, the sulphurets, tellurets, arseniurets, &c.; 3. HYPOGENS, the feldspars and related silicates; 4. PERIGENS, magnesia and aluminous hydrosilicates; 5. EPIGENS, carbonates, sulphates, chlorids, fluorids, &c.; 6. METAGENS, garnet, pyroxene, mica, tourmaline, spinel, &c.

J. H. SCHRÖDER: Elemente der rechnenden Krystallographie, with 73 figures and 5 lithographic plates. Clausthal, 1859.

J. W. BRÜCKE: 118 Stück Gypsabgüsse von naturlichen sowohl einfachen Krystallen.—Models of crystals including especially twins of the feldspars, by J. W. Brücke. Berlin, 1857. A pamphlet of 20 pages containing descriptions of the models.

H. D. ROGERS: The Geology of Pennsylvania, a Government Survey, with a general view of the Geology of the United States, Essays on the Coal Formation and its fossils and a Description of the Coal-fields of North America and Great Britain, by H. D. Rogers, State Geologist, Prof. Nat. Hist. Univ. of Glasgow, &c. 2 vols. 4to of 586 and 1046 pages, with numerous plates, maps, sections and woodcuts.—Prof. Rogers has given in his great work a number of analyses of mineral coal and iron ores, besides describing at length the mines of Pennsylvania.

J. Hall and J. D. Whitney: Report on the Geological Survey of the State of Iowa, embracing the results of investigations made during portions of the years 1855, 56, 57. 725 pp. large 8vo, with numerous plates.—Prof. Whitney has published analyses of various limestones, dolomites, iron ores, coals, and treated also briefly of the lead region of the Upper Mississippi.

W. E. Logan: Geological Survey of Canada, Report of Progress, for the year 1857. 240 pp. 8vo.—Contains information on the economical minerals of Canada, and a paper on Dolomites by T. S. Hunt.

O. M. Lieber: Report III. on the Geological Survey of South Carolina. 224 pp. 8vo with maps. 1858.—Contains chapters on the gold and other minerals and rocks of a part of South Carolina.

Hanns Bruno Geinitz: Das Königliche mineralogische Museum in Dresden. 110 pp. 12mo.—A catalogue of the minerals of the Dresden Museum and a plan of the building and arrangements.

C. U. Shepard: Report of the Mount Pisgah Copper Mine. 8 pp. 8vo. New Haven, 1859.—The copper ore is chalcopyrite. It occurs in gneissoid mica schist. The other minerals of Mt. Pisgah are vivianite in fine crystals, automolite, apatite, hyalite, staurotide, tremolite, chrysocolla, etc. An impure chlorite from the region is named *lepidochlore*. There is no analysis given, and no other good foundation for the new name.

In the same pamphlet, Prof. Shepard proposes names for mineral substances (of which he promises future descriptions) from Ducktown, a copper mine in the same vicinity, in eastern Tennessee. These names are *Copperasine* for a "hydrated ferrous cuprous and ferric sulphate;" *Leucanterite* for an efflorescence on the copperasine; *Erusibite* for a "rusty insoluble ferric sulphate;" *Stephensonite* for a "hydrosulphato-carbonate of copper, of a chrysoprase green color." Until they are fully described by the author, and complete analyses given, with other evidence that they are good species, these names can have no claims to recognition in the science. A common blackish copper ore from Ducktown is named *ducktownite*, making five so-called species from Ducktown. The mineral appears to the eye to be only a mixture. H.=5·5. G.=4·55—4·66 (Mr. R. A. Fisher). Color blackish steel-gray with a shade of bronze. Said to contain 30·76 iron, 26·04 copper, with 43·20 undetermined, but set down as "sulphur, by difference."

Prof. G. J. Brush has handed me the following notices of the Ducktownite and Lepidochlore.

"Having recently visited the Ducktown mines, I have obtained specimens of the so-called new species *ducktownite*, and after assuring myself of their authenticity by comparison with a specimen received from Prof. Shepard, I have submitted them to examination. A careful inspection with the magnifier shows that besides the quartz, malachite and limonite mentioned by Prof. Shepard, that the mass is made up of an intimate mixture of two substances, one of which has a bronze and the other a steel or blackish-gray color. Occasionally the mixture contains a small quantity of yellow copper pyrites. The bronze colored mineral selected as carefully as possible gave the following characters. Before the blowpipe in matrass yielded a copious sublimate of sulphur, indicating one of the higher sulphids. Pulverized and roasted in an open tube gave a reaction for sulphur and left a reddish residue. Fused on charcoal the assay became magnetic. A specimen carefully roasted on charcoal till sulphur ceased to be given off, was dissolved in salt of phosphorus; it gave a reaction for iron only, no reaction for copper was obtained even on fusing the bead with chlorid of sodium, thus proving the mineral to be entirely free from copper. Its hardness was sufficient to scratch feldspar; this together with the reactions in the matrass and on charcoal indicate that the substance under examination was *iron pyrites*.

The blackish-gray substance gave off no sulphur when examined in the matrass, but yielded sulphurous acid when treated in the open tube and on charcoal, and showed the presence of a large amount of copper. In hardness it was very inferior to the bronze mineral, but its mixture with the latter prevented an accurate determination. An assay made of a fragment of this mixture, containing a small amount (not over one or two per cent at most) of malachite and perhaps also a

small quantity of limonite, gave 46·70 per cent of metallic copper. The mixture with iron pyrites and the associating minerals was such that it was almost impossible to select the blackish-gray mineral pure.

These facts, however, are sufficient to prove that *ducktownite* is not a homogeneous substance. The low amount of copper obtained by Prof. Shepard is explained by his specimen having contained a very considerable admixture of iron-pyrites. The substance I have examined is a mixture of iron-pyrites and a rich sulphid of copper, which if obtained pure would probably prove to be copper-glance. I am requested by Dr. R. A. Fisher to state that the specific gravities quoted by Prof. Shepard were taken upon fragments which contained malachite, quartz, and limonite, and are of no value further than as an approximative density of the ore.

In Professor Shepard's description of the substance he calls *lepidochlore*, he quotes me as authority for its specific gravity and chemical composition. The only examination I have made of it was to determine the density and the amount of water it contained, and in my report to Prof. Shepard I gave these with the remark, '*appears to be a mixture of chlorite and mica*.' Prof. Shepard gives no physical or chemical characters which distinguish the mineral from chlorite."

Ch. Herpin: Sur la Nomenclature et la Classification des eaux Minérales. 8vo. Paris, 1859.

J. Houël: Des principales eaux minerales de l'Europe. 8vo. Paris, 1858.

On the Microscopical Structure of Crystals, by H. C. Sorby, Quart. Journ. Geol. Soc., xiv, 453.—Treats mainly of the cavities in crystals, and draws from them some conclusions with regard to the origin of the rocks in which the crystals occur.

A list of pseudomorphic minerals occurring in Scotland, by Dr. Heddle (Phil. Mag., [4], xvii, 42.

On Pseudomorphism, or the Perimorphosis of Calcite and Epidote into Garnet, by A. Knop of Giessen, Jahrb. Min., 1858, 33.

On Heteromerism and Heteromerous minerals, by R. Hermann, J. f. pr. Chem., lxxiv, 256—314, lxxv, 385—448.

Alteration of Minerals.—Dr. H. Eichhorn has published (Pogg., cv, 126) an important paper on this subject. Pulverized *chabazite* was exposed to different weak solutions. (1) 4·0 grams of chabazite in water containing 4·0 grams of common salt to 400 cubic centimetres, for 10 days in the cold; (2) 15·0 grams, with 10·0 grams of chlorid of ammonium and 500 c. c. of water for 21 days; (3) 15 0 grams, with 20 grams crystallized carbonate of soda and 500 c. c. of water, for 21 days; (4) 15·0 grams with 10·0 grams of carbonate of ammonia in 500 c. c. water for 21 days. The following are analyses of true chabazite and the altered products:

	$\dddot{Si}$	$\dddot{\bar{A}l}$	$\dot{C}a$	$\dot{K}$	$\dot{N}a$	$\dot{H}$
Chabazite,	47·44	20·69	10·37	0 65	0·42	20·18 = 99·75
Altered " 1,	48·31	21·04	6·65	0·64	5·40	18·33 = 100·37
" " 2,	51·26	22·17	4·15	[0·61]		14·87 AmO 6 94 = 100
" " 3,	48·39	20·76	5·64	6 86		18·46 = 100·11
" " 4,	50·61	21·26	5·63	[0·87]		15·72 AmO 5·91 = 100.

Descriptions of Species.

Aciculite.—This ore from Beresowsk, has afforded R. Hermann (J. f. pr. Ch. lxxv, 450):

S 16·50 Bi 34·37 Pb 36·31 Cu 10·97 Ni 0·36 Au 0·09 = 99·00

corresponding to the formula $(\text{Cu}, \text{Pb})\text{S} + 3\text{Bi S}^3$.

ADELPHOLITE, *A. E. Nordenskiold* (Beskrif. Finland Min., &c., Jahrb. Min. 1858, 313).—A niobate or tantalate of iron and manganese with 9·7 per cent of water. Crystallization dimetric, the angles undetermined. H.=3·5—4·5. G.=3·8. Lustre greasy, subtranslucent. Brownish yellow to brown and black. Streak white or yellowish white. From Rajamaki in Tamela, Finland, with beryl and small crystals of tantalite.

AGALMATOLITE [p. 252, V].—Scheerer has referred the minerals from China included under Agalmatolite to three groups (Handwört. Chem.).

1. Common agalmatolite *or hydrous potash-alumina silicate.—First division* containing 1$\dot{K}$, 3$\dddot{A}$l, 6$\dddot{S}$i, 3$\dot{H}$, [Min., p. 253, anal. 1, 2]. A *second* kind is mentioned under this group having the same constituents except 3$\dot{R}$ in place of 1$\dot{K}$. It is based on Thomson's analysis. [Min., anal. 3.]

2. *A hydrous alumina-silicate.*—He here includes Klaproth's analysis (Beit., ii, 189), $\dddot{S}$i 62, $\dddot{A}$l 24, $\dot{C}$a 1, $\dot{F}$e$\dot{O}$ 0·05, $\dot{H}$ 10—97·50; also Lychnell and Walmstedt's [Min., p. 253].

3. *A hydrous magnesia-silicate,* or *steatite.*

Under the first group he places, besides Chinese specimens in a *first* division, the agalmatolite of Nagyag analyzed by Klaproth [Min., anal. 2]; a *second* that of Ochsenkopf, analyzed by John, and near Onkosin; a *third* the agalmatolite of Schemnitz, analyzed by Karafiat [Min., anal. 4], and the parophite and dysyntribite. These three divisions differ in having for the protoxyds, the first 1$\dot{R}$, the second 2 $\dot{R}$, the third 3$\dot{R}$.

[Scheerer, in his valuable paper, fails to note that *parophite* was described as a *rock* and not as a mineral by T. S. Hunt; and that *dysyntribite* was also proved to be a rock by Smith and Brush. The relation to agalmatolite is undoubted. But owing to the impurities present, it is not safe to infer the precise composition from the analyses. G. J. Brush in his article on the Gieseckite of Northern New York (this Jour., xxvi, 64, July, 1858, and VI Suppl., p. 350), shows that this gieseckite is in fact a potash-agalmatolite, and as it comes from the same region with the dysyntribite it is obvious that the latter is the same compound in an impure state. The constituents found by him were 6$\dot{R}$, 7$\dddot{R}$, 12$\dddot{S}$i, 9$\dot{H}$=($\dot{R}^3$, $\dddot{R}$, $\dot{H}^3$)$\dddot{S}$i, which brings it most nearly to the third division. Prof. Brush also shows that the potash-pinites and liebenerite are related to the gieseckite and potash-agalmatolite. Besides, in his remarks on pyrophyllite (same vol. this Jour., p. 68), he proves that the "hydrous alumina silicate" agalmatolite, or that of the second group, is compact pyrophyllite, as suggested by Walmstedt.—D.]

ALISONITE, *Field* (this Jour., [2], xxvii, 387).—Alisonite is a sulphuret of lead and copper, from "Mina Grande," near Coquimbo, Chili. It has a deep indigo-blue color, quickly tarnishing on exposure; G.=6·10; H.=2·5—3. Associated with cerusite and malachite, and also vanadate of lead and copper. Composition:

S 17·00 Cu 53·63 Pb 28·25 = 98·88

corresponding to 3CuS, PbS, which requires Cu 53·33, Pb 28·88, S 17·77.

ANALCIME [p. 318, IV].—Rammelsberg has published some analyses of analcime in Pogg., cv, 317, sustaining the received formula. He mentions reasons for doubting the analysis of von Waltershausen [Min., No. 8].

APATITE [p. 396, I—VI].—An apatite from Krageroe, Norway, according to Völcker (Rep. Brit. Assoc., Dublin, 1857) contains no fluorine.

ARAGONITE [p. 448, II, III, IV, V].—The variety of aragonite containing lead, called *tarnowitzite,* has been examined crystallographically by Websky (Zeits. D. geol. Ges., ix, 787). The crystals were from Lazarowka, one to three lines long, and one-fifth to one line through. The faces observed are I, i-$\breve{i}$, $\frac{1}{2}$-$\breve{i}$, 1-$\breve{i}$, 1, $\frac{1}{2}$, 2-$\breve{2}$, $\frac{4}{3}$-$\breve{2}$, $\frac{2}{3}$-$\breve{2}$, $\frac{1}{3}$-$\breve{2}$, $\frac{4}{5}$-$\bar{2}$, $\frac{2}{5}$-$\bar{2}$, $\frac{4}{5}$-$\frac{27}{25}$, $\frac{27}{2}$-$\frac{27}{25}$. The angles by measurement, I : I=116° 18′, I : 1=143° 36′. By calculation, 1-$\breve{i}$: 1-$\breve{i}$=108° 34′. Three very complex twins are finely figured on the plate.

A fine green aragonite occurs near Gerfalco in Tuscany, in radiated columnar forms. Marcel de Sevres attributes the color to the oxyds of copper and iron.—*L'Institut,* 1858, p. 351.

ASBOLAN OR EARTHY COBALT [p. 126].—On the occurrence of Cobalt, and nickel ores in Gaston Co., North Carolina, H. Wurtz (Am. J. Sci., [2], xxvii, 24).

AUTUNITE [p. 430, IV (p. 130), V, VII].—According to Descloizeaux, autunite is optically biaxial, and the prism, instead of square, is rhombic, with I : I=90° 43′.—*L'Institut,* 1859, 33.

BARNHARDITE [p. 500, I].—Under the name of *Homichlin*, Breithaupt has described an ore from Plauen in Voigtland (B. u. H. Zeit., xvii, 385, 424, and xviii, 65), identical with barnhardite in composition and other characters. Crystallization dimetric octahedral; mostly compact massive; G.=4·472—4·480; H.=4—5. Color a little more bronzy than chalcopyrite; streak black. *Composition* according to an imperfect analysis by T. Richter, Iron 22·1, copper 43·2, leaving 34.7 for sulphur and a small admixture of earthy substances. Richter writes the formula $2\text{Ɛ}uS+FeS^3$=Iron 22·2, copper 48·2, sulphur 30·5, which is precisely the composition given by Genth for the barnhardite. It is associated with kupferpecherz and malachite. Other localities are, Friedensgrube near Lichtenberg in Bavaria, Duchy of Hesse near Viedendorf, and at Breitenstein near Viedenkopf, Duchy of Nassau at Oberlahnstein, Kupferberg in Silesia, Johanngeorgenstadt, Lauterbach in the Hartz, Rheinbreitenbach on the Rhine, Quadmerget in Algeria, Chili at Remolinos and Tocopilla and Japan.

BARYTES [p. 366, II, V, VI].—The brachydome $\frac{1}{8}$-$\breve{i}$ has been observed by E. J. Chapman in a barytes crystal in the Museum of the University of Toronto (Canadian Jour. iv, 55).

BINNITE [II, III, IV].—This monometric mineral from Binnen valley contains, according to Stockar-Escher, (Kenngott's Min. Forsch. for 1856, '57, p. 174):

S	As	Cu	Ag
32·78	18·98	46·24	1·91

according to which the ratio for the As, S, Cu is 1 : 8 : 8, and he observes it is identical with *enargite* except in crystallization.

BLENDE [p. 45, II, V].—A brown blende from near Burbach in the Siegen district afforded C. Schnabel (Pogg., cv, 144) ZnS 70·45, FeS 12·59, insol. resid. 16·96 $=5ZnS+FeS$.

BOLTONITE [p. 167, I].—G. J. Brush has analyzed anew the boltonite of Shepard, and confirmed Dr. Smith's result that the mineral is *chrysolite*. He has also shown that the analysis of von Hauer, and the arguments of Kenngott based upon it, are wrong. He obtained (this Jour., xxvii, 395)—

$\dddot{Si}$	$\dot{M}g$	$\dot{F}e$	$\dot{C}a$	$\bar{\bar{A}}l$	ign.
42·82	54·44	1·47	0·85	*tr.*	0·76=100·34

It is therefore a very pure *magnesia-chrysolite*, a variety of the species not yet found elsewhere. H.=6—6·5. G.=3·21. Color ash-grey, but fragments almost colorless and nearly transparent. Cleavage very distinct in one direction. The crystals are imbedded in a limestone gangue, and the sections of them are often rectangular.

BORNITE.—See *Tetradymite.*

BREWSTOLINE [p. 471].—R. T. Simmlen has published a paper (Pogg., cv, 460), aiming to show that the expansible fluid observed by Brewster in topaz, quartz and amethyst, is *liquid carbonic acid.* The expansion of the Brewstoline in a change of temperature from 50° to 80° F. was 25 per cent; and according to Thilorier, liquid carbonic acid expands between 32° and 86° F. 45 per cent. In the former the rate per degree is 0·832, in the latter 0·833. The index of refraction of the Brewstoline, according to Brewster, is 1·1106 for a specimen in a Siberian amethyst, and 1 1311 for one in a Brazilian topaz, or less than the number for water (1·335); and although the exact number for carbonic acid has not been observed, it is stated by Davy and Faraday to be less than that of water.

BROCHANTITE [p. 391].—Brochantite, according to F. Sandberger (Pogg., cv, 614), occurs in Nassau, along with chalcopyrite, galena and chalybite, malachite and allophane. An analysis by H. Risse afforded $\dddot{S}$ 19·0, $\dot{C}u$ 67·8, $\dot{H}$ 13·2, and *trace* of chlorine, corresponding to the formula $\dot{C}u^7\dddot{S}^2+6\dot{H}$.

CALAMINE [p. 318, II].—Analysis of the white or colorless calamine from Santander in Spain, by C. Schnabel (Pogg., cv, 144):

$\dddot{Si}$	$\dot{Z}n$	$\bar{\bar{A}}l, \bar{\bar{F}}e$	$\dddot{\dot{P}}$	$\dot{H}$
23·74	66·25	1·08	*tr.*	8·34=99·41. G.=3·42.

CALCIFERRITE, *J. R. Blum* (Jahrb. Min., 1858, 287).—A mineral related to vivianite, of a sulphur-yellow, greenish yellow to siskin-green and yellowish white color, and sulphur-yellow streak; occurs crystalline foliated, with one very perfect cleavage affording thin lamellæ, and traces in two other directions, one at right angles to the perfect cleavage face and the other oblique. H.=2·5; G.=2·523—2·529, Reissig. Thin lamellæ translucent. B.B. affords a black shining magnetic globule. Easily decomposed by muriatic acid. Analysis by M. Reissig afforded—

	$\overset{\cdot\cdot\cdot\cdot\cdot}{P}$	$\ddot{\bar{Al}}$	$\ddot{\bar{Fe}}$	$\dot{C}a$	$\dot{M}g$	$\dot{H}$
	34·01	2·90	24·34	14·81	2·65	20·56=99·27
Oxygen,	19·16	1·35	7·27	4·23	1·06	18·27

affording therefore as the oxygen ratio for the protoxyds, sesquioxyds, phosphoric acid and water, nearly 6 : 9 : 20 : 20=$6\dot{R}$, $3\ddot{\bar{R}}$, $4\overset{\cdot\cdot\cdot\cdot\cdot}{P}$, $20\dot{H}$. Occurs in nodules in a deposit of clay at Battenberg in Rhenish Bavaria. The exterior of the nodules is massive and yellowish brown or reddish brown, and consists of the impure or altered calciferrite.

CALCITE [p. 435, I—VI].—A grass green cleavable calcite from Central India contains according to S. Haughton (Phil. Mag., [4], xvii, 16), a siliceous skeleton, amounting to about 14 per cent of the whole, to which it owes its green color. The skeleton afforded on analysis—

$\dddot{Si}$	$\ddot{\bar{Al}}$	$\dot{F}e$	$\dot{C}a$	$\dot{M}g$	$\dot{H}$ and loss
54·59	4·74	22·84	0·94	4·90	11·99=100

giving the formula $(\dot{R}^3, \ddot{\bar{R}})\dddot{Si}^2 + 3\dot{H}$. Mr. Haughton observes that the composition resembles that of *glauconite*. He names the rock, which is merely a mixture of calcite and the green mineral, Hislopite.

Analyses of many limestones by J. W. Mallet are given in Tuomey's Second Biennial Report on the Geology of Alabama; others by J. D. Whitney in Hall and Whitney's Report on Iowa.

CALDERITE.—See *Garnet*.

CASSITERITE.—The tin ore of the veins at Evingtok near Arksut, Greenland, where the cryolite occurs, is associated with ores of lead, copper, zinc, iron and molybdenum, fluor spar, zircon, cryolite, etc. The veins vary from 10 inches to ½ inch in width, and in the largest the tin ore occupies about 1 inch on one side of the vein.

CASTELNAUDITE [p. 432].—See *Xenotime*.

CIMOLITE [p. 165].—A whitish material, a little greasy in lustre, having G.=2·319, found with orthoclase in granite from Nagpur, India, has been analyzed by S. Haughton (Phil. Mag., [4], xvii, 18) and found to contain:

$\dddot{Si}$	$\ddot{\bar{Al}}$	$\dot{C}a$	$\dot{M}g$	$\dot{H}$ (ign.)
65·93	20·97	0·30	0·45	11·61=99·26

The oxygen ratio for the alumina (including protoxyds) and silica is about 1 : 3·36. It is stated to be gritty under the agate pestle. Mr. Haughton proposes for the species the name *Hunterite*.

[The species appears to be cimolite, as the characters and composition are essentially the same. The grittiness under the agate pestle appears to indicate a slight admixture of free silica.—D.]

COBALT, Black.—See *Asbolan*.

CONARITE, *Breithaupt*, B. u. H. Zeit., xviii, 1.—Supposed to be a hydrous phosphate of nickel. It occurs at Röttis in Voigtland with Breithaupt's Röttisite (which see). It is in small grains and crystals, with one perfect cleavage, and is probably monoclinic like vivianite, with the cleavage brachydiagonal. H.=2·5—3. G.=2·459—2·490. Color yellowish pistachio- and siskin-green, also olive-green; streak siskin-green. In thin lamellæ translucent. It is named from the Greek κωναρος, *evergreen*.

Copperasina.—See page 129.

CROCOISITE [p. 359].—Dauber has measured the angles of crocoisite with great care and published the results in Pogg. Ann., cvi, 150. He makes $I:I=86° 31'·6$, $i2:i2=50° 24'$, $C=77° 22' 43''$, with a possible error of $1' 52''$, and the axial ratio for the orthodiagonal, clinodiagonal and vertical axis, is 1 : 0·96383 : 0·91751.

DEWEYLITE [p. 285].—Kenngott in his last supplement (p. 67, published in 1859) continues to place Deweylite under *Gymnite*, although the former name has the priority.

DIALLOGITE [p. 446, III].—Massive diallogite has been found at Placentia Bay, Newfoundland (T. S. Hunt in Logan's Canada Rep. for 1857), in slates supposed to be of Silurian age. Color fawn- to chestnut-brown. H.=4. G.=3·25. It contains, according to T. S. Hunt, 84·6 p. c. of carbonate of manganese, with 14·4 per cent of silica, with small portions of iron, lime and magnesia. All but two per cent of the silica were readily soluble in a dilute solution of potash.

DOLOMITES [p. 441, I, II, IV].—Analyses of many dolomites of Alabama by J. W. Mallet are given in Tuomey's Second Biennial Geol. Report of Alabama; also of dolomites of Canada, by T. S. Hunt, in Logan's Geol. Rep. Canada for 1857; and in Iowa by J. D. Whitney in Hall and Whitney's Iowa Report.

Dolomitic veins or spots in fossiliferous limestone.—According to the investigations of T. S. Hunt (Logan's Canada Rep. for 1857, p. 200), the grayish fossiliferous limestone of Dudswell is ordinary limestone consisting of carbonate of magnesia 1·3, sand 6·2, and the rest carbonate of lime. The fossils have a similar composition. But a yellowish material envelops the fossils or fills the veins, which is dolomitic, consisting of—

$\dot{C}a\ddot{C}$	$\dot{M}g\ddot{C}$	$\dot{F}e\ddot{C}$	Insoluble, sand
56·60	11·76	3·23	26·72 = 98·31

There is here a mixture of dolomite and carbonate of lime; by means of acetic acid the latter was removed (with but 4·0 p. c. of carbonate of magnesia) and the residue (52 per cent) then gave

$\dot{C}a\ddot{C}$	$\dot{M}g\ddot{C}$	$\dot{F}e\ddot{C}$
51·75	35·73	12·52 = 100

The *Portor* marble, a well-known black marble with yellowish veins, brought from the Gulf of Spezzia (and according to Savi of the Neocomian formation), also analyzed by Mr. Hunt, afforded the same results. The body of the rock contained only 1·0 per cent of carbonate of magnesia, while the veins afforded 35·5 per cent.

Ducktownite.—See page 129.

DUFRENOYSITE [p. 77, I, II, III, IV, V].—This prismatic mineral from Binnen valley, contains, according to Stockar-Escher, (Kenngott's Min. Forsch. for 1856, '57, p. 177):

S	As	Pb	Ag	Fe	
23·97	22·01	53·30	0·24	——	= 99·52
24·22	25·27	49·22	0·94	0·25	= 99·90
25·30	26·33	46·83	1·62	——	= 100·08
25·77	26·82	47·39	*trace*	——	= 99·98

The mean result gives the formula $3PbS+2As^2S^3$. The last two analyses also approach the formula $4PbS+3As^2S^3$, which differs from that of plagionite or jamesonite, in the substitution of arsenic for antimony.

ELLAGITE, *A. E. Nordenskiöld* (Beskrifv. Finl. Min. etc., and Jahrb. Min., 1858, 313).—Probably monoclinic; two cleavages making 90° with one another. Lustre of cleavage surface pearly, shining; opake or feeble translucent. Color yellow, yellowish brown to yellowish red. Streak uncolored. B.B. yields water and with greater heat an enamel-white pearl. From Aoland in Finland. Formula deduced $\dot{C}a^3\ddot{S}i^4+\ddot{\bar{A}}l\,\ddot{S}i+12\dot{H}$.

ENARGITE.—*F. Field* has described (this Jour., xxvii, 52) under the name of *Guayacanite*, an arsenical sulphuret of copper which he has identified with enargite. It contains, according to Field, S 31·32, As 19·14, Cu 48·50=99·46, with traces of iron and silver. The formula deduced is $3CuS+AsS^5$. H.=3·5—4. G.=4·39.

EPIDOTE [p. 306, II—VI].—Scheerer has published (J. f. pr. Chem., lxxv, 167) a paper opposing the analytical results of Hermann with regard to the presence of carbonic acid in epidote. In the epidote of Bourg d'Oisans and Arendal, Scheerer found neither carbonic acid nor protoxyd of iron. He states that the same error extends to Hermann's analyses of idocrase.

Erusibite.—See p. 129.

FRANKLINITE [p. 166, I].—Franklinite in crystals occurs at the mine Victoria near Eibach in Nassau, according to C. Koch. The crystals are cubic. This species was first announced as existing in Nassau at the mine Breitehek by Jung in 1834.—Kenngott's Min. Forsch. for 1856, '57, p. 145.

GALENA [p. 39, II, III, IV].—A galena affording before the blowpipe, like cupro-plumbite, some copper and a trace of antimony, occurs at the mine of Antonio Cruz near Comayagua in Honduras, according to W. J. Taylor (Proc. Acad. N. Sci. Philad. Aug. 1858).

GARNET [p. 190, I—VI].—A mineral from Nepal named *Calderite* is, according to Söchting, massive garnet.—Kenngott's Min. Forsch. for 1856, '57, p. 115.

Analysis by R. Richter of a dark-red garnet from Mt. Agiolla in Traversella, Piedmont (Scheerer, in Kön. Sächs. Ges. der Wiss., 1858, p. 99):

$\dddot{Si}$	$\dddot{\bar{A}l}$	$\dddot{\bar{F}e}$	$\dot{C}a$	$\dot{M}g$
39·99	17·98	6·45	32·70	2·76=99·88

Oxygen ratio for $\dot{R}$, $\bar{\bar{R}}$, $\dddot{Si}$=10·44 : 10·33 : 20·76.

Damour on the Subdivision of the Garnets into four groups.—L'Institut, xxiv, 441, and Jahrb. Min., 1858, 77.

GLAUCONITE.—See under *Calcite*, and this Supplement.

GERSDORFFITE [p. 58].—Gersdorffite is found in fine crystals near Ems. Composition according to C. Bergemann (J. f. pr. Chem., lxxv, 244):

As	Sb	S	Ni	Co	Fe
45·02	0·61	19·04	34·18	0·27	1·02=100·14

It corresponds to the formula NiS^2+NiAs.

GOLD [p. 7, I, II, V, VI].—Native gold occurs in Australia imbedded in apatite.

GONGYLITE *Thoreld*, A. E. Nordenskiöld (Beskrif. Finl. Min. etc., Jahrb. Min., 1858, 313).—An altered mineral occurring massive with cleavage in two directions. G=2·7. H.=4—5. Lustre greasy, subtranslucent. Yellow or yellowish brown. Streak white. B.B. yields water and with a stronger heat fusing to a blebby glass. Formula, according to Thoreld, $(\dot{M}g, \dot{K})^3\dddot{Si}^2+3\bar{\bar{A}}l\dddot{Si}^2+4\tfrac{1}{2}\dot{H}$, if a part of the iron is taken as protoxyd. From Yli Kitkajärvi in Finland.

GUAYACANITE.—See *Enargite*.

GYMNITE.—See *Deweylite*.

HEMATITE [p. 113, II, III, IV].—Rammelsberg (Pogg., civ, 541) has found the martite (octahedral ore) of Brazil to contain 1·83 to 2·30 per cent of ptotoxyd of iron, and is inclined to regard it as a pseudomorph. Sp. gr. 5·155.

The octahedral iron of Vesuvius (ib., p. 542) contains according to Rammelsberg, while mostly $\bar{\bar{F}}e$, either some protoxyd of iron or magnesia. Rammelsberg obtained (1.) $\bar{\bar{F}}e$ 85·90, $\dot{M}g$ 12·43, insoluble 1·22; (2.) $\bar{\bar{F}}e$ 82·52, $\dot{M}g$ 15·68, insol. 2·00; (3.) $\bar{\bar{F}}e$ 92·91, $\dot{F}e$ 6·17, $\dot{M}g$ 0·82. The crystals are magnetic, and consist of hematite in laminæ through a magnesian magnetite. Specific gravity of 1 and 2, 4·654 and 4·659, which is less than in either hematite or magnetite; of 3, 5·235.

HERSCHELITE [under Gmelinite, 321].—Descloizeaux has found that *herschelite* has a negative axis of refraction, and *hydrolite*, which is considered a variety of herschelite, a positive axis.—L'Institut, 1859, 33.

HOMICHLIN *Breithaupt*.—See *Barnhardite*.

HORNBLENDE [p. 170, I, II, III, IV, VI].—Scheerer has reviewed at some length the paper on the composition of the Hornblende and Pyroxene group of minerals, in Pogg., cv, 598.

HYALOPHANE [I, III, V].—Stockar-Escher has analyzed hyalophane and found it to contain (Kenngott's Min. Forsch., 1856, '7, p. 107):

$\dddot{\mathrm{Si}}$	$\bar{\dddot{\mathrm{Al}}}$	$\dot{\mathrm{Ba}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Na}}$	ign.
52·67	21·07	15·05	0·46	0·04	7·82	2·14	0·58=99·83

This makes it an oligoclase with part of the protoxyds replaced by baryta, giving the formula $(\dot{\mathrm{K}}, \dot{\mathrm{Ba}})\dddot{\mathrm{Si}}+\bar{\dddot{\mathrm{Al}}}\dddot{\mathrm{Si}}^2$. Specific gravity =2·801.—Kenngott's Min. Forsch. for 1856, '57, p. 107.

ILMENITE [p. 115, II, V].—The varieties of titanic iron have been investigated recently by Rammelsberg (Pogg., civ, 497). The following are the mean results of his analyses. The last column contains the ratio of $\dot{\mathrm{Fe}}\ddot{\mathrm{Ti}}$ to $\bar{\dddot{\mathrm{Fe}}}$ which he has deduced from the composition. 1, from Ingelsberg near Hof-Gastein, [same analyzed by von Kobell, Min. No. 1]; 2, Layton's Farm, near Warwick, Orange Co., New York; 3, Ilmen Mts., Ural [Min., Nos. 3, 4, 5, and Schmidt below]; 4, Egersund, Norway [Min., Nos. 7, 8, 9, 10]; 5, Krageröe, Norway; 6, *Iserine*, from Iserwiese; 7, *Washingtonite*, Litchfield, Ct. [Min., Nos. 13, 14]; 8, Eisenach; 9, Snarum, Norway; 10, Binnen Valley; 11, *Eisenrose*, St. Gothard [Min., No. 17]; 12, Krageröe.—The analyses A, B, C, are of anomalous titanic irons; A, Iserine, in grains which may be octahedral, or rhombohedral with the apex truncated; B, from the basalt of Unkel [Min., under Iserine]; C, titaniferous iron sand, magnetic, from the shores of Muggle Lake near Berlin.

	Sp. gr.	$\ddot{\mathrm{Ti}}$	$\bar{\dddot{\mathrm{Fe}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{Mg}}$	Ratio. $\dot{\mathrm{Fe}}\ddot{\mathrm{Ti}}$: $\bar{\dddot{\mathrm{Fe}}}$
1.	4·689	53·03	2·66	38·30	4·30	1·65= 99·94	1 : 0
2.	4·313 & 4·293	57·71	——	26·82	0·90	13·71= 99·14	1 : 0
3.	4·81—4·873	45·93	14·30	36·52	2·72	0·59=100·06	6 : 1
4.	4·744 & 4·791	51·30	8·87[a]	39·83	*trace*	0·40=100·40	9 : 1
5.	4·701	46·92	11·48	39·82	——	1·22= 99·50	9 : 1
6A.	4·752	37·13	28·40	29·20	3·01	2·97=100·71	3 : 1
6B.	4·676	42·20	23·36	30·57	1·74	1·57= 99·44	3 : 1
7.	4·986	23·72	53·71	22·39	0·25	0·50=100·57	1 : 1
8.	5·060	16·20	69·91	12·60	0·77	0·55=100·03	1 : 2
9.	4·943	10·02	77·17	8·52	——	1·33 $\bar{\dddot{\mathrm{Al}}}$ 1·46=98·50	1 : 4
10.[b]	5·127 & 5·150	9·18	81·92	8·60	——	——= 99·70	1 : 4
11.	5·187 & 5·209	9·10	83·41	7·63	0·44	*tr.* =100·58	1 : 4
12.	5·2406	3·55	93·63	2·26	——	——=100·44	1 : 13
A.	4·400	57·19	15·67	26·00	——	1·74=100·60	
B.	4·905	8·27	51·81	37·22	2·03	0·78=100·11	
C.	5·075	5·20	61·36	30·25	1·23	0·48= 98·52	

[a] Trace of $\dot{\mathrm{Mn}}$. [b] Mean of two analyses.

The more important conclusions of Rammelsberg from his researches are as follows:—(1.) The common composition is $\dot{\mathrm{Fe}}\ddot{\mathrm{Ti}}$. (2.) Magnesia in the most of them replaces part of the protoxyd of iron; and in that from Layton's farm near Warwick, it amounts to 14 per cent, the composition corresponding to the formula $\dot{\mathrm{Fe}}\ddot{\mathrm{Ti}}+\dot{\mathrm{Mg}}\ddot{\mathrm{Ti}}$. (3.) The preferable theory for the composition of the species is that of Mosander which makes it a titanate of protoxyd of iron, $\dot{\mathrm{Fe}}\ddot{\mathrm{Ti}}$ (the iron sometimes replaced by magnesium) with often more or less $\bar{\dddot{\mathrm{Fe}}}$, and usually in simple proportions; Rose's theory considers the varieties combinations of isomorphous sesquioxyds of titanium and iron, and this would require the existence of a sesquioxyd of magnesium. Rammelsberg also concludes that there is no true octahedral titanic iron, and that Iserine (analysis A) is a combination of $\dot{\mathrm{Fe}}\ddot{\mathrm{Ti}}$ and $\bar{\dddot{\mathrm{Fe}}}\ddot{\mathrm{Ti}}^3$ in the ratio of 4 : 1.

[The ratios between the $\dot{\mathrm{Fe}}\ddot{\mathrm{Ti}}$ and $\bar{\dddot{\mathrm{Fe}}}$ deduced by Rammelsberg are not in most cases the precise results of the analyses. Thus in No. 4, the ratio obtained for the protoxyds, titanic acid and sesquioxyd, 0·8 : 2·7 : 6 is made 1 : 3 : 6; and so in some other cases. Rejecting the idea of any titanate of iron being present, and taking simple the atomic ratio between the metals and the oxygen, according to Laurent's view of the constitution of such compounds, all the 12 analyses come quite closely under the formula of hematite, M^2O^3 (the species with which titanic iron is isomorphous), M standing for all the iron, titanium, manganese and magnesium that is

present. The following table shows that, excepting one or two cases, the coincidence is quite remarkable.

	Metals.	Oxygen.	Ratio.		Metals.	Oxygen.	Ratio.
Anal. 1.	21·77	32·11	1 : 1·48	Anal. 7.	20·52	30·80	1 : 1·50
" 2.	22·71	34·64	1 : 1·52	" 8.	20·29	30·62	1 : 1·51
" 3.	20·67	31·55	1 : 1·50	" 9.	20·14	30·29	1 : 1·50
" 4.	20·09	32·11	1 : 1·60	" 10.	20·07	30·14	1 : 1·50
" 5.	20·58	31·48	1 : 1·53	" 11.	20·23	30·44	1 : 1·50
" 6A.	21·17	31·67	1 : 1·50	" 12.	20·13	30·22	1 : 1·50
" 6B.	20·62	31·64	1 : 1·54				

In analysis A, the corresponding numbers are 20·62 : 33·96=1 : 1·65 ; in B, 21·11 : 27·87=1 : 1·32 ; in C, 21·47 : 27·65=1 : 1·29. The last two are nearly the ratios of magnetic iron (1 : 1·33), and, as Rammelsberg suggests, they appear to be titaniferous magnetite. As to A, which holds an excess of oxygen, Rammelsberg queries reasonably whether the collection of iserine grains might not have contained some free titanic acid (grains of the black variety of rutile), but concluded that it was improbable.—J. D. D.]

Crystals of ilmenite an inch and a half in diameter and half an inch thick have been found, according to W. J. Taylor (Proc. Ac. N. Sci. Philad., August, 1858), in a boulder on the Schuylkill near Fairmount, Pa.

Iolite [p. 214].—A pseudomorph after iolite called *peplolite*, from Ramsberg in Sweden, has been examined by O. P. Carlsson (Kong. Vet. Akad. Förh. 1857, 241). H. = 3—3·5. G. = 2·68—2·75. The mean of three analyses, one by Mr. Sieurin, second by Aomark, and third by Carlsson, gives for the composition:

$\dddot{S}i$	$\bar{\dddot{A}}l$	$\dot{F}e$	$\dot{M}n$	$\dot{C}a$	$\dot{M}g$	$\dot{H}$	
45·95	30·51	6·77	*tr.*	0·50	7·99	8·30	= 100·02

whence the oxygen ratio for $\dot{H}$, $\dot{R}$, $\bar{\dddot{R}}$, $\dddot{S}i$, 1·52 : 1·00 : 2·95 : 4·93.

Iron (native) [p. 17, II].—Pieces of native iron are reported to have been found at Chotzen in Bohemia, imbedded in a limestone, the *Plänerkalk* (K. A. and J. G. Neumann, in the Jahrb. k. k. Geol. Reichs., 1857, 354). J. G. Neumann suggests that it is of meteoric origin, of the age of the Plänerkalk. An analysis afforded, Iron 98·33, graphite 0·74, arsenic 0·32, nickel 0·61. Its structure is not at all crystalline.

Iwaarite.—See *Schorlomite*.

KARELINITE, *R. Hermann* (J. f. pr. Chem., lxxv, 448).—Karelinite is an oxydsulphuret of bismuth, according to the analysis by Hermann, which afforded—

Oxygen 5·21 Sulphur 3·53 Bismuth 91·26

whence the atomic ratio for O, S, Bi, 3 : 1 : 4, corresponding to BiO^3+BiS. It is from the Sawodinsk mine in the Altai Mts., where it occurs with telluric silver. Lustre metallic. Fracture crystalline, cleavage perfect in one direction. Color lead-gray. H.=2. G.=6·60. It is mixed with gray earthy bismuthite ($3\bar{\dddot{B}}i\ddot{C}+\bar{\dddot{B}}i\dot{H}^4$). B.B. gives fumes of sulphurous acid, and a gray slag with a bead of bismuth. Named after Mr. Karelin who brought it from Siberia.

Kapnicite [V].—This mineral, according to the examinations of Städeler, is probably wavellite, it containing $\dddot{\dddot{P}}$ 35·49, $\bar{\dddot{A}}l$ 39·59, with 24·92 (loss) water.—Kenngott's Min. Forsch. for 1856, 1857, p. 33.

Keilhauite [341, I, III].—Analysis of the Keilhauite by Rammelsberg (Pogg. Ann., cvi, 296):

	$\dddot{S}i$	$\ddot{T}i$	$\bar{\dddot{F}}e$	$\bar{\dddot{A}}l$	$\dot{C}a$	$\dot{Y}$	$\dot{M}n$	$\dot{M}g$	$\dot{K}$	ign.
1.	29·48	26·67	6·75	5·45	20·29	8·16	*trace*	0·94	0·60	0·54
2.	28·50	27·04	5·90	6·24	17·15	12·08	*trace*	*trace*	—	3·59

The second was made on a crystal, but it was a little altered and softened at the surface. Rammelsberg obtains for the oxygen of $\dot{R}$, $\bar{\dddot{R}}$, $\ddot{T}i$, $\dddot{S}i$, the ratio 7·79 : 4·56 : 10·59 : 15·31 in No. 1, and 7·30 : 4·68 : 10·73 : 14·80 in No. 2. He unites the oxygen

of the silica and titanic acid, and derives thence for $\dot{R}+\ddot{\bar{R}}$, $\ddot{T}i+\ddot{S}i$, the ratios 1 : 2·09, 1 : 2·13, and writes the formula $5(\dot{C}a, \dot{Y})\ddot{S}i+(\ddot{\bar{A}}l, \ddot{\bar{F}}e)\ddot{T}i^3$.

[The mean of the two analyses affords in fact very nearly $7{\cdot}5\dot{R} : 1{\cdot}5\ddot{\bar{R}} : 5\tfrac{1}{4}\ddot{T}i : 5\ddot{S}i$ (=7·5 $\ddot{S}i$), or $5\dot{R} : 1\ddot{\bar{R}} : 3{\cdot}5\ddot{T}i : 5\ddot{S}i$, which gives one-sixth too much titanic acid for the above formula. Under ilmenite (page 136) it is shown that the composition of that species is best expressed by a formula in which the titanium is not in the state of titanic acid, but in that of a metal replacing the other metals, in accordance with Laurent's theory. The fact confirms the view taken of sphene in the Mineralogy, in which Rose's formula, $2\dot{C}a\ddot{S}i+\dot{C}a\ddot{T}i^2$ (=$3\dot{C}a+3\ddot{T}i+2\ddot{S}i$) is made equivalent to $\ddot{\bar{R}}^3\ddot{S}i^2$, (since $\dot{C}a+\ddot{T}i=RO+RO^2=R^2O^3$, and $3\dot{C}a+3\ddot{T}i=3R^2O^3=3\ddot{\bar{R}}$). The oxygen ratio between the silica and other ingredients in sphene is 2 : 3. Now in the above analyses by Rammelsberg, there is the same oxygen ratio between the silica and the other ingredients, it being in No. 1, 15·31 to 22·94=2·002 : 3·000, and in No. 2, 14·80 : 22·71=1·96 : 3; 2 : 3 is therefore the *fundamental* ratio of the species (and this is so, of course, whether silica be $\ddot{S}i$ or $\dddot{S}i$). Hence comes the formula $(\dot{R}^3, \ddot{\bar{R}})^3\ddot{S}i^2$, which is equivalent to $(\dot{R}^3, \ddot{\bar{R}})\dddot{S}i^{\frac{4}{3}}$, as given in the Mineralogy, p. 341, from Erdmann's analysis, and since confirmed by Forbes. Erdmann's analyses, as calculated by Rammelsberg, afford the same result, giving for the ratio 15·58 : 23·79 =1·97 : 3; and 15·30 : 23·44=1·96 : 3.—J. D. D.]

KRANTZITE, *C. Bergemann* (J. f. p. Chem., lxxvi 65).—Krantzite is a fossil resin from the brown coal of Lattorf, and had been considered impure amber. It occurs in grains and roundish pieces, showing by its structure that it was once fluid. Color yellowish, but mostly brown to black from earthy impurities. It is so soft as to be easily cut, and is elastic; no peculiar smell; G.=0·968; or of the crust portion 1·002. Fuses at 225° C. without change of color, and is perfectly fluid at 288°; at 300° there distils over a brownish oil of very disagreeable and penetrating odor.

LABRADORITE [237, II].—A. E. Nordenskiöld has given the name *Ersbyite* to the anhydrous scolecite of Nordenskiöld the father [Min., p. 287]. It is monoclinic, or perhaps triclinic, and has the formula $\dot{C}a\ddot{S}i+\ddot{\bar{A}}l\ddot{S}i$, the formula of labradorite. From Ersby.—Beskrifv. Finl. Min. etc., in Jahrb. Min., 1858, 313.

LAPIS LAZULI [229, VI].—Two Siberian localities of lapis lazuli are described by N. Wersseloff in the Bull. de la Soc. Imp. des Naturalistes de Moscou, 1857, No. 4, p. 518. The mineral occurs in limestone intersecting syenite. As remarked by Nordenskiöld, the colorless and greenish lapis lazuli becomes blue on heating.

LAZULITE [404, II].—Lazulite occurs in beautiful sky-blue crystals in Lincoln Co., Georgia, on Graves' Mountain, about twelve miles northwest of the auriferous belt known as the Columbian gold mines, 50 miles above Augusta, as described by C. U. Shepard (this Jour., [2], xxvii, 36). In the same region occur kyanite, rutile, pyrophyllite, hematite. The lazulite occurs in certain layers of a bed of itacolumite disseminated through them in crystals from one-quarter to one inch long. The paper contains figures of the forms.

LEADHILLITE [371].—According to C. U. Shepard (this Jour., xxvii. 40) occurs in small quantities at the Morgan Silver Mine, in Spartanburg District, S. C., with pyromorphite and cerusite.

LEPIDOMELANE [227].—The black mica, &c., see Geol. Soc. Proc. in Phil. Mag., xvi, p. 396.

LIMONITE [131, II, IV].—Analyses of various limonites of Alabama are given in Tuomey's Second Biennial Geol. Rep. of Alabama.

LIROCONITE [429].—The crystallization of liroconite, according to Descloizeaux (L'Institut, 1859, 33) is monoclinic, having $I : I=74° 21'$, and the vertical axis inclined 25° from a vertical.

MAGNETITE [105, II, IV, VI].—Rammelsberg in Pogg., civ, 536, gives several analyses. In some there is a little magnesia. One from basalt near Eisenach,

afforded 0·10 titanic acid and 1·20 magnesia, with $\ddot{\text{F}}\text{e}$ 69·88, $\dot{\text{F}}\text{e}$ 27·88=99·06. See further under ilmenite and hematite.

MELLITE [475, II].—A new locality has been found in Russia, in the district of Nertschinsk, at the mine of Dmitrirwsk, in bituminous coal.

MICROCLINE [242, VI].—Breithaupt has described (Berg. u. Hütt. Zeit., xvii, 324) a twin consisting of albite and microcline, in which the two have the vertical axis parallel and the faces of perfect cleavage (*P*) precisely coincident, showing an identity in the inclinations of the planes. Breithaupt cites an analysis from Pogg., lii, 467, by Awdajeff, agreeing with microcline in the composition, affording, viz., $\dddot{\text{S}}\text{i}$ 67·20, $\ddot{\text{A}}\text{l}$ 20·03, $\ddot{\text{F}}\text{e}$ 0·18, $\dot{\text{K}}$ 8·85, $\dot{\text{C}}\text{a}$ 0·21, $\dot{\text{M}}\text{g}$ 0·31, $\dot{\text{N}}\text{a}$ 5·06, the formula of which may be written [$\dot{\text{K}}\dddot{\text{S}}\text{i}+\ddot{\text{A}}\text{l}\dddot{\text{S}}\text{i}^3$]+[$\dot{\text{N}}\text{a}\dddot{\text{S}}\text{i}+\ddot{\text{A}}\text{l}\dddot{\text{S}}\text{i}^3$].

MOLYBDENITE [66, I, IV].—Observations on the crystallization of molybdenite are published by A. Knop, in Jahrb. Min., 1858, 43.

NATROLITE [327, VI].—R. Blum has a paper on the pseudomorphs of natrolite after oligoclase and nepheline, from the zircon-syenite of Norway, in Pogg., cv, 133, showing that the natrolite is not an original mineral of the rock, as Scheerer argued, but a result of alteration.

NEOTOKITE [169].—This mineral, according to A. E. Nordenskiöld (Beskrif. Finl. Min., Jahrb. Min., 1858, 313, and Kopp's Jahresb. for 1857), has the formula $\dot{\text{M}}\text{g}\dddot{\text{S}}\text{i}+4(\ddot{\text{F}}\text{e}, \ddot{\text{M}}\text{n})\dddot{\text{S}}\text{i}+8\dot{\text{H}}$. It is amorphous. G.=2·7—2·8. H.=3·5—4·0. Color black to brownish-black. Streak brown. Opaque or feeble subtranslucent. B.B. yields water, but is infusible. From Gaosböle in Finland.

NICKEL ORES.—C. Bergemann has described (J. f. pr. Chem., lxxv, 239) two new arsenates of nickel, differing from the common arsenate in containing no water and also pure oxyd of nickel. They occur at Johann-georgenstadt.

(1.) Crystalline, sometimes amorphous. Dark grass green. H.=4. G.=4·838. No fumes on heating in a glass tube. B.B. on charcoal, arsenical fumes.

(2.) Amorphous. Sulphur-yellow. H.=4. G.=4·982. With heat like the preceding. Composition:

	$\dddot{\text{A}}\text{s}$	$\dddot{\text{P}}$	$\dot{\text{N}}\text{i}$	$\dot{\text{C}}\text{o}$	$\dot{\text{C}}\text{u}$	$\ddot{\text{B}}\text{i}$	$\ddot{\text{F}}\text{e}$	
(1.)	36·57	0·14	62·07	0·54	0·34	0·24	*tr.*	= 99·90
(2.)	50·53	*tr.*	48·24	0·21	0·57	0·62	—	=100·17

Formula of (1.) $\dot{\text{N}}\text{i}^5\dddot{\text{A}}\text{s}$=arsenic acid 38·01, oxyd of nickel 61·99.

Formula of (2.) $\dot{\text{N}}\text{i}^3\dddot{\text{A}}\text{s}$=arsenic acid 50·54, oxyd of nickel 49·46.

(3.) The *oxyd of nickel* occurs in regular octahedral crystals with faces of the rhombohedron, one-half a line long. Color dull pistachio-green. H.=5—6. G= 6·398. Composition, pure protoxyd of nickel. The crystals are not perceptibly attacked by acids or by fusion with alkaline carbonates.

NICKEL-GYMNITE [286].—Reported by W. J. Taylor (Proc. Ac. N. Sci. Philad., Aug. 1858) from Webster, Jackson Co., N. C., where it occurs as an amorphous reniform incrustation in serpentine along with chromic iron. Color apple-green to a yellowish-green. H.=3.

Breithaupt has described under the name of *Röttisite* (B. u. H. Zeit., xviii, 1) an impure hydrous silicate of nickel from Röttis in Voigtland. It occurs in amorphous masses and incrustations or seams, of a nearly pure emerald-green to apple-green color, apple-green streak, little lustre, translucent to subtranslucent, and opaque when earthy; H.=2—2·5; G.=2·358—2·370. An analysis by C. Winkler is given as follows:

$\dddot{\text{S}}\text{i}$	$\ddot{\text{A}}\text{l}$	$\ddot{\text{F}}\text{e}$	$\dot{\text{N}}\text{i}$	$\dot{\text{C}}\text{o}$	$\dot{\text{C}}\text{u}$	$\dot{\text{H}}$	$\dddot{\text{P}}$	$\dddot{\text{A}}\text{s}$
39·15	4·63	0·81	35·87	0·67	0·40	11·17	2·70	0·80

The sum is stated to be 100·79, but the numbers as they stand add up only 96·25 (or 4·54 less). The analyst observes that the sum of the silica, oxyd of nickel and water is 91·42 (it is as printed 4·63 less or 86·79), and thence deduces the formula $3\dot{\text{N}}\text{i}\dddot{\text{S}}\text{i}+4\dot{\text{H}}$=Silica 48·31, $\dot{\text{N}}\text{i}$ 39·15, $\dot{\text{H}}$ 12·54. It hence appears that there is a ty-

pographical error in the statement of the silica of between 4 and 5 per cent. [The mineral is said to occur with a *phosphate* of nickel (see *Conerite*); but the chemist, instead of allowing part of the oxyd of nickel to be combined with the 3·50 of phosphoric and arsenic acids (which might take up 2 per cent), and part of the silica with the alumina, selects out the silica, oxyd of nickel and water, and uses these alone to make out a formula. There is no sufficient evidence that the mineral is not identical with the *nickel-gymnite* of Genth (see Min., p. 286).—D.]

Orthoclase [242, II, III, V, VI].—The feldspar of the zircon-syenite has been analyzed by Dr. C. Bergemann (Pogg., cv, 118) and the view confirmed of its being a soda-bearing orthoclase.

Osteolite [398].—The osteolite of the Kratz mountain near Friedland in Bohemia, a snow-white earthy mineral having G.=2·828 to 2·829, afforded Dürre (Pogg., cv, 155):

$\dddot{\text{P}}$	$\dot{\text{Ca}}$	$\ddot{\text{Si}}$	$\ddot{\text{Al}}$	$\ddot{\text{Fe}}$	$\dot{\text{Mg}}$	Cl	$\dot{\text{H}}$
34·64	44·76	8·89	6·14	0·51	0·79	*tr.*	2·97=98·70

The phosphate is mixed with a silicate; the former contains of the above, $\dddot{\text{P}}$ 34·64 and $\dot{\text{Ca}}$ 40·985. The silicate has the composition nearly of an epidote, the formula being $\dot{\text{Ca}}^3\ddot{\text{Si}}+2\ddot{\text{Al}}\ddot{\text{Si}}$.

Pectolite [305, II, III, VI].—Analyses 5, 6, in the author's Mineralogy are of the pectolite of Bergen Hill, New Jersey.

PELICANITE.—This mineral occurs as the base of a granitic rock in Russia, in the government Kiew, and is announced and described by Ouchakoff. (Bull. de St. Petersbourg, No. 369, p. 129, Jour. f. Prakt. Chem. lxxvi, 255, and Kopp's Jahresb. for 1857, 673). It is related to cimolite, a product of decomposition. The color is pale greenish; fracture conchoidal; at the edges translucent. G.=2·256. B.B. burns white and does not melt even on the edges. Composition:

$\ddot{\text{Si}}$	$\ddot{\text{Al}}$	$\ddot{\text{Fe}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	$\dot{\text{K}}$	$\dddot{\text{P}}$	$\dot{\text{H}}$	Quartz
58·90	20·49	0·39	*tr.*	0·50	0·29	0·16	8·35	10·30=99·38

affording the formula $\ddot{\text{Al}}\ddot{\text{Si}}^3+2\dot{\text{H}}$.

Perofskite [345, II, IV, VI].—Descloizeaux has found (L'Institut, 1859, 33) that perofskite has two axes of double refraction quite distant, with the bisectrix negative. This was observed on specimens of a brownish yellow color from Zermatt and the Urals; and it is a question whether the black crystals from the Urals, which appear to be monometric, are not pseudomorphs.

Phosphorchalcite [425, II, VI].—The *Ehlite* from Ehl, has been analyzed by Dr. C. Bergemann and found to contain vanadic acid. His analysis afforded (Jahrb. Min., 1858, 195):

	$\dddot{\text{P}}$	$\dddot{\text{V}}$	$\dot{\text{Cu}}$	$\dot{\text{H}}$
	17·89	7·34	64·09	8·90
Oxygen,	10·12	1·90	12·98	7·90

Pyrophyllite [303, I, V, VI].—A mineral resembling massive pyrophyllite, according to W. J. Taylor (Proc. Ac. N. Sci. Philad., Aug. 1858), but not yet analyzed, containing imbedded quartz crystals, at a coal mine in Schuylkill Co., Pa. It is a tough, whitish mineral with a pearly lustre, somewhat greasy feel, forming a layer not over one-eighth inch thick.

Locality of pyrophyllite in Georgia, see under *Lazulite*.

Pyroxene [158, I, II, V, VI].—The pale green *smaragdite* of the euphotide of the Alps afforded T. S. Hunt (this Jour., [2], xxvii, 348):

$\ddot{\text{Si}}$	$\ddot{\text{Al}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	$\dot{\text{Fe}}$	$\ddot{\text{Cr}}$	$\dot{\text{Ni}}$	$\dot{\text{Na}}$	ign.
54·30	4·54	13·72	19·01	3·87	0·61	*tr.*	2·80	0·30—99·15
		14·22	18·07	2·34				

whence the oxygen ratio for $\dot{\text{R}}$, $\ddot{\text{R}}$, $\ddot{\text{Si}}$, 13·29 : 2·12 : 28·96.

The *traversellite* of Scheerer is a leek-green mineral, having the crystalline form of pyroxene, from Traversella in Piedmont in a mine of magnetic iron. It is softer

than this mineral but looks like a slightly altered variety. Composition according to R. Richter (Pogg. Ann., xciii, 109):

Si	Al	Fe	Ca	Mg	H
52·39	1·21	20·46	7·93	14·41	3·69=100·09

The oxygen ratio for the H, R, R, Si, is 3·28 : 12·58 : 0·56 : 27·20. The crystals are rectangular prisms, having the faces *i-i*, *i-ĭ* large, and *I* small, with the basal plane *O*. (Ber. Kön. Sächs. Ges. der Wiss., June 1858, p. 92.) Scheerer regards the mineral as an example of what he calls *paramorphosis*.

Pyrgom, according to Scheerer (Ber. Kön. Sächs. Ges. der Wiss., June 1858, p. 96) is augitic in crystallization. Richter obtained:

Si	Al	Fe	Mn	Ca	Mg
31·79	4·03	7·57	*trace*	18·98	17·40=99·77

giving the oxygen ratio for R, R, Si, 14·06 : 1·88 : 26·89. The form is a rhombic prism *I*, with the pyramidal planes +1, −1, +2, −2, and occasionally some others.

Quartz [145, II, III, IV].—A peculiar form of quartz, from different localities, and mostly the rock called melaphyre, has been named by Dr. Jenzsch (Pogg., cv, 320) *Vestan*, under the idea that it is a distinct species, quartz being therefore considered dimorphous. The form given is monoclinic and imperfect unequal cleavage is stated to occur in three directions. The angles are stated to be only approximative. Two of them, 95½° and 133°, are very near angles in quartz (*R*:*R* and *R*:-*R*).

RETZBANYITE, *R. Hermann* (J. f. pr. Chem., lxxv, 450).—This is a bismuth ore resembling telluric silver, and from Retzbanya. Color lead-gray, but externally oxydized and mixed with cerusite and bismuth ochre. In irregular pieces with no trace of crystalline structure. H.=2·5. G.=6·21. B.B. fumes of sulphurous acid; with soda is reduced to a globule of lead and bismuth. Afforded on analysis by R. Hermann:

O	S	Bi	Pb	Ag	Cu
7·14	11·93	38·38	36·01	1·93	4·22=99·61

giving the atomic ratio for the oxygen, sulphur, bismuth, and other metals, 8 : 7 : 3 : 4, and making, according to Hermann, a compound of a sulphate and oxysulphuret, with the formula [2CuS, PbS+3BiS]+2PbS.

Röttisite, *Breithaupt*.—See *Nickel-Gymnite*.

Rutile [120, V].—In the vicinity of the lazulite locality, Lincoln Co., Georgia (see lazulite), occur, according to C. U. Shepard (this Jour., xxvii, 36), splendent gigantic crystals of rutile, some weighing upwards of a pound. One has six geniculations.

Saponite.—A hydrous aluminous silicate from the waters at Plombières has been analyzed by J. Nicklès and designated *Saponite*, a name that has for some time belonged to a magnesian silicate. The mineral was found to consist of Silica 42·30, alumina 19·20, water 38·54, equivalent to $AlSi^3$+12H, or near cimolite.—L'Institut, No. 1318, April 6, 1859.

Saussurite [234, II, IV, VI].—The doubts about saussurite have been well cleared up by T. S. Hunt (this Jour., [2], xxvii, 336). He shows that three species have been confounded under the name—similar in a white or a pale greenish white color, and a tough compact texture—viz. (1.) Labradorite or a related feldspar; (2.) Epidote; (3.) Garnet. The original saussurite of the euphotide of the Alps is a lime-alumina epidote, having G.=3·25—3·36.

Schorlomite [342, IV].—A. E. Nordenskiöld has described (Beskrif. Finland Min., &c., from Jahrb. Min., 1858, 312) a mineral having apparently the characters of schorlomite under the name of *Iwaarite*. Like schorlomite it is found in Elæolite, is lustrous iron-black resembling black or crystallized melanite, with the streak gray, and contains much titanium. It is either in monometric crystals or massive. The analysis is not cited in the Jahrbuch. The formula given is Ca^3Si+FeSi+½TiO, Ti^2O^3, while that written for schorlomite by Whitney is Ca^3Si+FeSi+$CaTi^2$.

B.B. fuses to a black glass. Comes from Iwaara in the Kunsamo Kirchspiel in Finland.

Scorodite [419, I].—Lippmann has named a mineral found in small bluish crystals at Schneeberg, *Cobalt-scorodite.* It occurs with hypochlorite and quartz.—Kenngott's Min. Forsch. for 1856, 1857, p. 84.

Serpentine (282, I—VI].—Antigorite, shown to be slaty serpentine by G. J. Brush, has since been analyzed by Stockar-Escher with the same result (Kenngott's Min. Forsch., 1856, '7, 72). The mean of two analyses is—

Si	Al	Fe	Mg	H
40·83	3·20	5·84	36·26	12·37=98·86.

Stockar-Escher regards the alumina as replacing the silica.

Kenngott has described under the name of *Vorhauserite*, a mineral from the Fleims Valley in the Tyrol at Monzoni, having the composition of *Retinalite*, but impure with a little oxyd of manganese and iron. It occurs amorphous, of a brown to greenish-black color; weak waxy lustre; yellowish, pale or brownish yellow to brownish streak; H.=3·5; G.=2·45. Analysis by J. Oellacher (Kenn. Min. Forsch., 1856–57, p. 71):

Si	Mg	Fe	Mn	H	
41·21	39·24	1·72	0·30	16·16,	CaCl, Ca^3P 0·9=99·59

Retinalite is probably *serpentine* mixed with a little Deweylite.

A pseudomorph after chromic iron occurs in Unst, according to Dr. Heddle (Phil. Mag., [4], xvii, 42).

Smithsonite [447, I, III].—Smithsonite from near Wiesloch contains carbonate of cadmium. It has a citron-yellow to wax-yellow color. An analysis in the laboratory of Prof. Bunsen afforded:

ZnC	CdC	CaC	FeC	MgC	Zn, H	ZnS	Sand
89·97	3·36	2·43	0·57	0·32	1·94	0·47	0·45=99·51

Specular Iron.—See *Hematite.*

Sphene [268, III].—A Vesuvian mineral hitherto referred to the species sphene (the semeline of Fl. de Bellevue) has been described by G. Guiscardi under the name of *Guarinite*, after Prof. G. Guarini of Naples. (Zeit. D. geol. Gess. x, 14.) It is stated to occur in *dimetric* crystals, with difficult cleavage. Color honey-yellow. Translucent or transparent. Lustre subadamantine and adamantine on cleavage faces. H.=6—6·5. G.=3·487. Composition:

Si	TiO^2	Ca	Fe, Mn
33·64	33·92	28·01	*trace* = 95·57

The author observes that the composition is near that of the sphene of Piedmont (Greenovite, *Dufr.*).

Stiblite [142].—An antimony ochre occurs with antimonial nickel-glance and spathic iron near Eisern in the Siegen District, and contains, according to C. Schnabel (Pogg., cv, 146) Ni 0·17, Fe 5·56, H 9·42, along with antimonious acid 84·85. The oxyd of iron is hydrated.

SUNDVIKITE, *A. E. Nordenskiöld* (Beskrif. Finl. Min., and Jahrb. Min., 1858, 313).—An altered anorthite.

Tetradymite [21, 512, I].—C. U. Shepard has described (this Jour., [2], xxvii, 39) tetradymite from Lumpkin Co., Ga. It occurs in gneiss. It is associated with gold, pyrrhotine, chlorite, ilmenite in broad curved crystals, and some allanite and apatite. He observes that it is also found at the Pascoe Mine in Cherokee Co., and at a place near Van Wort in Polk Co.

Dr. C. T. Jackson has analyzed the tetradymite of Dahlonega, Georgia, and ascertained that it is the mineral, usually arranged under tetradymite, called bornite. He obtained (this Jour., [2], xxvii, 366):

Te	Se	Bi	Gold (mixed)
18·00	1·18	79·08	0·60 = 98·86

agreeing nearly with the analyses of the Brazilian bornite by Damour. Sp. gravity =7·868.

THERMOPHYLLITE [Suppl. VI].—The thermophyllite of Hoponsuo contains, according to A. B. Northcote (mean of two analyses) Phil. Mag., [4], xvi, 263:

$\dddot{\text{Si}}$	$\dddot{\bar{\text{Al}}}$	$\dot{\text{Fe}}$	$\dot{\text{Mg}}$	$\dot{\text{Na}}$	$\dot{\text{H}}$	$\dot{\text{H}}$ expelled at 212° F.
41·48	5·49	1·59	37·42	2·84	10·58	0·30 = 99·70

It is stated to occur in aggregated masses of a brownish gray color and semi-translucent, in some parts micaceous, through a rock of massive thermophyllite; crystalline form not determinable. [It resembles vermiculite in appearance and action before the blowpipe.]

TITANIC IRON.—See *Ilmenite*.

TOURMALINE [270, II, IV].—A fine large pinite-like pseudomorph after tourmaline, three inches long and two in diameter, is described by Mr. Tamnau (Zeits. D. geol. Ges., x, 12). It contains some unaltered black tourmaline. The crystal is a 6-sided prism with the faces also of a 12-sided prism. It was from Rosenbach in Silesia.

VAUQUELINITE [360].—Occurs, according to W. J. Taylor (Proc. Ac. N. Sci. Philad. Aug. 1858), at the Pequa Lead Mine, Lancaster Co., Pennsylvania, in minute crystals with acute terminations, often in radiated aggregations incrusting quartz and galena. The color varies from siskin to apple-green. Small crystals of *cerusite* occur in the cavities of the galena.

VORHAUSERITE, *Kenngott*.—See *Retinalite* under Serpentine.

WAVELLITE [423, IV].—A compound approaching wavellite in composition, occurs, according to A. Gages (Jour. Geol. Soc., Dublin, viii, 73), forming the cement of a conglomerate found as a boulder near Loughhill, county of Limerick. It is composed of small emerald-green crystals mingled with some white ones and forming mamillary concretions. Analysis by A. Gages:

$\dddot{\text{P}}$	$\dddot{\bar{\text{Al}}}$	$\dddot{\bar{\text{Fe}}}$	$\dot{\text{Ni}}$	Fl	$\dot{\text{H}}$	$\dddot{\text{Si}}$	
30·88	36·16	1·81	0·33	*tr.*	23·56	3·61	apatite 1·58, quartz 1·00=98·94

The formula deduced is $(\bar{\text{Al}},\bar{\text{Fe}})^5\dddot{\text{P}}^3+18\dot{\text{H}}$, but it is stated to be proposed merely as an expression of a single analysis.

On the formula of Kapnicite by Städeler.—Liebig's Ann., cix, 305.

WHITNEYITE, *Genth* (this Jour., [2], xxvii, 400).—Whitneyite is an arseniuret of copper containing about 12 per cent of arsenic, or 1 equivalent of arsenic to 18 of copper =copper 88·37, arsenic 11·63=100. Structure massive crystalline, fine granular. H.=3·5. G.=8·408 (at 16° C.). Lustre metallic; color pale reddish-white; tarnishes readily, becoming yellowish and changing to brown and finally to brownish-black; sometimes iridescent. Somewhat malleable. Composition according to F. A. Genth:

As	Cu	Ag and insoluble
11·81	88·07	0·33=100·21
11·41	88·19	0·47=100·07

B.B. fuses readily, giving off fumes of arsenic. Insoluble in chlorhydric acid; soluble in nitric. Found coated with red copper in Houghton Co., Michigan. One boulder weighing 40 pounds was found at the Pewabic Mine. Stated to occur in a vein four inches wide, about one mile from the Cliff Mine, at the Albion location; also found at the Minnesota mine. Named after Prof. J. D. Whitney, author of the "Mineral Wealth of the U. States."

XENOTIME [401, I, II, III].—The Castelnaudite of Damour, according to a recent analysis (Bull. Géol. [2], xiii, 542, Kopp's Jahresb. for 1857, 686), is xenotime. An analysis afforded Damour $\dddot{\text{P}}$ 31·64, $\dot{\text{Y}}$ 60·40, $\ddot{\text{Ti}}$ and $\ddot{\text{Zr}}$ 7·40, $\bar{\text{U}}$ and $\bar{\text{Fe}}$ 1·20=100·64.

ZINC.—Native zinc has been announced as occurring on the Mittamitta river, Australia, 160 miles northeast from Melbourne. It contains a little cadmium.—Jahrb. Min., 1857, 698.

ZINC-BLOOM [460, 513].—The zinc-bloom of Santander near Comillas in Spain has been analyzed by T. Petersen and E. Voit (Ann. d. Ch. u. Pharm., cviii, 48). The following are their results: (1A) the interior of a mass and (1B) the same after a slight alteration; and also other analyses (2, 3) of the Spanish mineral by Mr. Braun (loc. cit.):

	$\dot{C}$	Zn	$\dot{H}$
1A.	15·1	73·1	11·8 =100
1B.	13·81	74·73	11·45= 99·99
2.	13·33	73·15	12·96, mixed Calamine 1·34
3.	14·32	73·83	11·87=100·02

The constitution deduced from 1A, is $3\dot{Z}n, 3\dot{C}, 6\dot{H}$; from 1B, $\dot{Z}n\dot{C}+2\dot{Z}n\dot{H}$.

Analysis of zinc-bloom from a lead mine near Romsbeck in Westphalia by C. Schnabel (Pogg., cv, 144): $\dot{C}$ 12·30, $\dot{Z}n$ 64·04, $\dot{C}u$ 0·62, $\ddot{F}e$ and $\ddot{A}l$ 2·58, $\dot{C}a$ 0·52, $\dot{H}$ 13·59, hygroscopic water 2·02 (by drying in a water-bath), siliceous residue 3·88, $\dot{M}g$, $\dot{M}n$, $\dddot{S}$ *traces*=99·45=$\dot{Z}n^3\dot{C}+3\dot{H}$.

SCIENTIFIC INTELLIGENCE.

I. PHYSICS AND CHEMISTRY.

1. *On the oxyd of ethylene.*—A. WURTZ has found that when glycol, $C_4H_4O_2+2HO$, is saturated with muriatic acid gas and heated in a closed tube water is set free and a new ether formed. The reaction is represented by the equation

$$C_4H_6O_4+HCl=C_4H_5ClO_2+2HO.$$

The new ether is a colorless neutral liquid soluble in water and boiling at 128°. The author considers this body as between glycol, $C_4H_6O_4$, and the Dutch liquid, $C_4H_4Cl_2$. A solution of potash decomposes the new ether giving chlorid of potassium and the oxyd of ethylene, $C_4H_4O_2$. The oxyd of ethylene—the true ether of glycol—is isomeric with aldehyd. It is a colorless liquid which boils at 13°·5 under a pressure of 746·5: aldehyd boils at 21°. The oxyd of ethylene is soluble in water in all proportions, and gives with bisulphite of soda a crystalline compound. It forms no crystalline compound with ammonia. Perchlorid of phosphorus converts it into Dutch liquid. We have, namely, the equation

$$C_4H_4O_2+PCl_5=C_4H_4Cl_2+PO_2Cl_3.$$

By a similar process Wurtz has prepared the oxyd of propyl-glycol, $C_6H_6O_2$. The relations between the diatomic ethers and aldehyds are best exhibited by the formulas

$$\left.\begin{matrix}C_4H_3O_2\\H\end{matrix}\right\}\text{Aldehyd}\qquad C_4H_4\,.\,O_2\qquad\text{Ethylen oxyd}$$

$$\left.\begin{matrix}C_6H_5O_2\\H\end{matrix}\right\}\text{Propionic aldehyd}\qquad C_6H_6\,.\,O_2\qquad\text{Propylen oxyd.}$$

Comptes Rendus, xlviii, 101.

2. *On the chemical constitution of lactic acid.*—KOLBE has brought forward a new view of the constitution of lactic acid which connects this body in a very interesting manner with the acids homologous with formic acid. The author in the first place refers to the fact that the researches of Perkin and Duppa may be regarded as proving that glycocine is amido-acetic acid. By the action of nitrous acid upon glycocine, alanin,

&c., a series of acids is obtained homologous with lactic acid, and of which glycolic acid is the first term. Kolbe regards these acids as resulting from the acids of the formic series by the replacement of one equivalent of hydrogen in the radical by one of peroxyd of hydrogen HO_2. Thus acetic acid being

$$C_4H_3O_3+HO$$

glycolic acid is $C_4H_2(HO_2)O_3+HO$ and may be termed oxy-acetic acid. In like manner lactic acid is oxy-propionic acid and so on. Considered as amido-acetic acid glycosin has the formula $C_4H_2(NH_2)O_3+HO$. To test the correctness of Kolbe's view Ulrich has instituted experiments to determine whether the acids of the formic series can be prepared from those of the glycolic series, and has succeeded in transforming lactic into propionic acid by a simple process. This consists in acting upon lactate of lime by perchlorid of phosphorus by which the chlorid of chloropropioxyl is formed. Brought into contact with water this gives chloropropionic and muriatic acids, according to the equation

$$C_6H_4ClO_2.Cl+2HO=C_6H_4ClO_3, HO+HCl.$$

By the action of nascent hydrogen chloropropionic acid may be converted into propionic acid. By the action of perchlorid of phosphorus upon lactate of lime Wurtz obtained a liquid which he termed chlorlactyl and to which he gave the formula $C_6H_4O_2Cl_2$. The true constitution of this liquid appears however from the above. Wurtz's view that lactic acid with the formula $C_6H_6O_4$ is bibasic also falls to the ground, if lactic is really oxypropionic acid. Kolbe further denies that glycol and its homologues and glycerin and its homologues are really alcohols, and prefers to confine this term exclusively to the hydrates of monatomic radicals. According to his view the glyoxylic acid of Debus is dioxyacetic acid, so that we have the series

Acetic acid	$C_4H_3O_3$, Ho
Oxyacetic acid	$C_4H_2(HO_2)O_3$, HO
Dioxyacetic acid	$C_4H(HO_2)_2O_3$, HO

Glyceric acid is then dioxypropionic acid. In like manner anisic acid may be regarded as oxytoluic acid. Kolbe suggests that the alcohols and aldehyds of the oxy-acids are derived from the alcohols and aldehyds of the primitive acids by simple replacement of hydrogen by HO_2, exactly like the oxy-acids themselves. It must be admitted that his views, to say the least, are very ingenious and suggestive.—*Ann. der Chemie und Pharm.*, cix, 357.

3. *On the Compounds of Valeral with Acids.*—GUTHRIE and KOLBE have obtained combinations of valeral—the aldehyd of valerianic acid—with acetic and benzoic acids. Both of these compounds contain two equivalents of acid to one of oxyd, but are not identical with the isomeric acetate and benzoate of amyl-glycol. Guthrie had already obtained a biacid acetate of common aldehyd. These results all go to prove distinctly that the ethers of the glycol series are not identical with the aldehyds, and fully confirm the results of Wurtz as above stated, (1). They further show, moreover, that the aldehyds in their relations to acids are referable to the type of two equivalents of water and not of two equivalents of hydrogen.

4. *On the Simple Acetate of Glycol and the preparation of Glycol.*—ATKINSON has found that the bromid of elayl is easily decomposed by certain salts of potash. By the action of bromid of elayl upon acetate of potash, the author succeeded in preparing acetate of elayl in considerable quantity. The bromid and acetate are to be dissolved in equal quantities in alcohol of 85 per cent, and the whole, after being well corked, exposed for two days to the temperature of boiling water. The liquid is then to be distilled: that which passes over between 180° and 185° is the simple acetate of glycol $\left.\begin{matrix} C_4H_4 \\ C_4H_3O_3 \\ H \end{matrix}\right\} O_4$. This is a colorless oily liquid heavier than water, and miscible with this and with alcohol. Potash and baryta easily decompose this compound into glycol and an acetate. Instead of the bromid of elayl, chlorid of elayl may be employed in preparing the acetate of glycol; but in this case the mixture must be heated to 100° for three or four days at least. Glycol bears the same relation to the simple acetate of glycol, that a bibasic acid bears to its acid salt.

The author obtained glycol by distilling the acetate with caustic potash. The glycol thus obtained exhibited all the properties of that body described by Wurtz.

5. *On Organic Compounds containing Metals.*—BUCKTON has obtained several very interesting compounds by the action of metallic chlorids upon zinc-ethyl. Chlorid of mercury acts with great violence upon zinc-ethyl, so that the containing vessel must be cooled by means of water and the well dried chlorid added gradually. The apparatus is then to be warmed, when mercur-ethyl passes over by distillation as a heavy, colorless liquid, almost free from odor. The pure mercur-ethyl C_4H_5Hg boils between 158° and 160° C. It takes fire easily and burns with a luminous, somewhat smoky flame, giving out vapors of mercury. Dilute acids act but little upon it, but concentrated muriatic or sulphuric acids give off ethyl-hydrogen, while the salts of mercur-ethyl, $C_4H_5Hg_2$, remain in solution. The density of the vapor of this compound was found to be 9·97, its calculated density for 2 vols. would be 8·68.

The author also obtained the same compound by the action of zinc-ethyl upon the iodid of mercur-ethyl. By the action of chlorid of lead upon zinc-ethyl, Buckton obtained a radical having the formula $(C_4H_5)_2$ Pb. This substance is a colorless fluid almost free from smell, insoluble in water, soluble in ether: it takes fire easily and burns with a beautiful orange colored flame, with a blue border giving off vapors of oxyd of lead. It appears to be incapable of forming salts without a partial decomposition, but the author obtained a crystalline chlorid and sulphate.

Chlorid of silver acts powerfully upon zinc-ethyl but does not yield a conjugate radical, the products of the action being ethyl, chlorid of zinc and metallic silver. When iodid of stann-ethyl is treated with zinc-ethyl and distilled, a colorless liquid passes over between 170° and 180°, which is a new stann-ethyl having the formula $(C_4H_5)_2Sn$. This body resembles the above mentioned lead compound, but is more stable. It is easily inflammable and burns like tin in the flame of the compound blowpipe. This radical differs in many respects from the stann-ethyl obtained by Frankland, which has the formula C_4H_5Sn. Muriatic acid attacks it with

difficulty; on heating there is a slow evolution of gas, and a chlorid is formed which appears to be richer in tin than the original radical. This chlorid crystallizes with difficulty and has an oily consistency at ordinary temperatures, it has a strong and penetrating smell, and on heating gives off a vapor which is very irritating to the skin. A corresponding bromid also exists, but the other salts are not yet described.

6. *On the Compounds of Organic Radicals with the Metals of the earths.*—HALLWACHS and SCHAFARIK have studied the action of iodid of ethyl upon several of the earthy metals. When magnesium is heated in a closed tube with the iodid, the metal is gradually converted into a white mass. On opening the tube gas is given off, and the white mass on heating yields a colorless volatile liquid, which has a penetrating smell of garlic. The slightest trace of air produces white clouds of magnesia, but the liquid does not take fire spontaneously. This liquid consists probably of hydro-carbons with traces of ethyl-magnesium. Finely divided aluminum foil when heated in a closed tube with twice its volume of iodid of ethyl, yields a thick syrupy liquid. On opening the tube a little gas is given off, but every drop of the liquid burns in the air magnificently, with formation of white, brown and violet vapors. The contents of the tube distilled in a current of carbonic acid yield a heavy colorless oil which has a very high boiling point, and which decomposes water most violently. This liquid is doubtless an ethyl-aluminum. The authors propose to extend their investigation to other metals. W. G.

7. *Faraday's Researches in Chemistry and Physics*—(Researches in Chemistry and Physics, by MICHAEL FARADAY, D.C.S., F.R.S., &c., &c.). London: Richard Taylor and William Francis, Printers and Publishers to the University of London. 1859. 496 pp. 8vo, with 3 plates.—The illustrious author of this volume says in his preface, "The reasons which induce me to gather together in this volume the various physical and chemical papers, scattered in the Philosophical Transactions and elsewhere, are the same as those which caused the Experimental Researches in Electricity to be collected into one series." Every student of these sciences will acknowledge a debt of gratitude to England's most distinguished philosopher for this new memorial of a life singularly fruitful of important results in physical science, while every young student will peruse with peculiar interest the early papers of Michael Faraday, written when he was as yet unknown to fame and rejoicing in the friendship and scientific guidance of Sir Humphrey Davy. The first paper, On the Native Caustic lime of Tuscany, appeared in the Quarterly Journal of Science (i, 260) in 1816. To this paper the author adds the following characteristic note.

"Reprint this paper at full length. It was at the beginning of my communications to the public, and in its results very important to me. Sir Humphrey Davy gave me the analyses to make, as a first attempt in chemistry, at a time when my fear was greater than my confidence and both far greater than my knowledge; at a time also when I had no thought of ever writing an original paper on science. The addition of his own comment and the publication of the paper encouraged me to go on, making from time to time other slight communications, some of which appear in this volume. Their transferrence from the 'Quarterly' into other journals increased my boldness; and now that forty years have elapsed and I can look back on what the successive communications have led to, I still hope, much as their character has changed, that I have not, either now or forty years ago, been too bold.—M. F."

The last paper in the present volume is the author's *Lecture on Mental Education*, in which he develops with vigorous thought his views on some of the popular delusions of the day.

II. GEOLOGY.

1. *Third Report on the Geological Survey of South Carolina;* by Oscar M. Lieber. 224 pp. 8vo. Columbia, S. C. Price of each Report 50 cents.—This Report treats particularly of Greenville and Pickens Districts. It gives information respecting the topography of the region, and the veins and metamorphic and eruptive rocks, and illustrates the distribution of the rocks on colored maps. A large part of the Report is occupied with a treatise on Itacolumite and the associate rocks, and their connection with the occurrence of gold. The associate rocks are *Specular schist* (a schist made up largely of specular iron), *Itabirite*, a rock consisting of arenaceous quartz and magnetite with some specular iron; *Catawbarite*, a talcose rock or schist with much magnetite; besides also an itacolumite conglomerate, and some limestone. Various reasons are given for believing that the itacolumite series are metamorphic palæozoic rocks. The origin of the gold in auriferous rocks is discussed at considerable length; but to clear up all difficulties connected with the subject, more facts are required than are yet known.

2. *Geological Survey of Canada;* Sir W. E. Logan, F.R.S., Director: *Figures and Descriptions of Canadian Organic Remains.* Decades I. and IV. 48 and 72 pp. 8vo, each with 10 plates. Montreal, 1859. B. Dawson.—The publication of the third Decade on the Organic Remains of Canada was announced in our last volume. Quite recently Decade I. has appeared in similar style, and with exquisite steel-plate engravings. This number is by the palæontologist Mr. J. W. Salter of London, while the engravings are by Mr. Sowerby. It takes up a portion of the Lower Silurian mollusks and illustrates the genera and species with great skill, bringing out much that is new respecting them. It represents finely the Maclurea Logani with its operculum, species of Ophileta, Raphistoma, Murchisonia, Cyclonema, Loxonema, Cyrtoceras, Ctenodonta (Hall's Tellinomya, this name being changed with good reason because the species are related not to Tellina or Mya, but to Arca), and others. There is one plate devoted to two species of Receptaculites.

Decade IV. also has just been issued. It is devoted to the Crinoids of the Lower Silurian, and is by Mr. E. Billings. Like the Decade on the Cystids it shows great success in the collection and study of the Canada Echinoderms. About fifty species are here included, five of which belong to the Chazy, and the rest to the Birdseye, Black River, Trenton, and Hudson River formations. The most remarkable species are certain forms of the Chazy, Pentremite-like in structure, for which the genus *Blastoidocrinus* is instituted. Another new genus of the Chazy is called *Palæocrinus*—the species P. striatus. It has five radiating ambulacral grooves on the summit. A second of the same rock is called *Hybocrinus;* and four are described from the Trenton. The species are well illustrated with lithographic plates.

3. *Geology of the Mexican Boundary Survey.*—The first volume of the Mexican Boundary Survey Report contains Geological Reports by Dr.

C. C. Parry and Assistant Arthur Schott, with notes by W. H. Emory; a Report on the Palæontology and Geology of the Boundary by James Hall: and Description of Cretaceous and Tertiary Fossils by T. A. Conrad, Esq.; and it is illustrated by a Geological Map by Mr. Hall, and numerous 4to plates of fossils by Conrad.

The date of the volume on the title page is 1857, but the true date of publication is the summer of 1858.

4. *Contributions to the Palæontology of New York:* being some of the results of investigations made during the years 1855, '56, '57, '58; by James Hall. 18 pp., 8vo. Albany, 1859.—This pamphlet contains descriptions of three new genera—*Palæarca*, *Megambonia* (near Ambonychia), and *Strophostylus* (a Natica-like univalve), besides a reference of the so-called *Acroculiæ* of the Palæozoic to Conrad's genus *Platyceras*, and a citation of the characters of Conrad's genus *Platyostoma*. The first genus is the same that was called *Cyrtodonta* by Billings in the Canada Geol. Rep. for 1857, p. 179; and Billings's name therefore has the priority. Mr. Hall states that the genus is in the third volume of his Palæontology. Unfortunately the volume is not published; and much more may yet be lost to the author, as priority of *publication* is the only just basis for any claim. Mr. Hall at the same time observes that the genus *Cypricardites* of Conrad was based on a shell probably of similar character. *Cyrtodonta* is of the Arca family, but has little resemblance in its teeth to Arca, there being but a few tooth-like folds at either extremity of the hinge surface; and it is still more remote from Cypricardia; hence both the names *Palæarca* and *Cypricardites* are objectionable. To the genus, are referred the *Edmondiæ* of the first volume of Hall's Palæontology, with *Ambonychia obtusa*, *Cardiomorpha vetusta*, *Modiolopsis latus* and *M. subspatulatus* of the same volume.

5. *The Geology of Pennsylvania:* a Government Survey, with a general survey of the Geology of the United States, Essays on the Coal-formation and its fossils, and a description of the Coal-fields of North America and Great Britain; by Henry Darwin Rogers, State Geologist, etc., in two vols. 4to, of 586 and 1046 pages, with numerous maps, plates, and wood-cuts. W. Blackwood & Sons, Edinburgh and London, J. B. Lippincott & Co., Philadelphia. 1858.—The geological survey of Pennsylvania by Prof. Rogers was commenced under the act of the Legislature of the State in the year 1836, and was continued on for six years. Again in 1851 it was resumed with reference to its completion, and continued until the spring of 1855, the limit allowed by the act of 1851.

The publication of the Report has been long and earnestly looked for, and it is a pleasure to see it finally issued in a style so excellent, and with a fullness of illustration and description that meets so well the demands of science and the interests of the State.

Prof. Rogers was aided by a corps of assistants, to the number of twelve through much of the time. In 1836 the assistants, as he mentions in his Preface, were John F. Frazer and James C. Booth. In 1837, they were Messrs. S. S. Haldemann, A. McKinley, C. B. Trego, J. D. Whelpley, with Dr. R. E. Rogers, chemist. In 1838 they were Messrs. H. B. Holl, A. McKinley, C. B. Trego, J. D. Whelpley, J. T. Hodge, R. M. Jackson, J. C. McKinney, P. W. Schaeffer, T. Ward, geologists, and Dr.

R. E. Rogers and M. H. Boye, chemists. In 1839 the corps was nearly the same, Peter Lesley and Dr. Henderson being added, and Messrs. Whelpley and McKinney resigning. In 1840 the corps was the same, with the addition of the draftsman, G. Lehman. In 1841 it was reduced to Messrs. McKinley, Holl, Jackson, Lesley, Boye, and Dr. Rogers. From 1851 the geological assistants were Prof. E. Desor and W. B. Rogers, Jr., and the topographers were Peter Lesley and subsequently A. A. Dalson. In the survey of a state of the extent of Pennsylvania (47,000 square miles in area) a very large part of the material for the Report must have been collected by the assistants; and Prof. Rogers acknowledges their energy and devotion in carrying forward the work.

The volumes take up first the Physical Geography of the State, as an Introductory to the Geology. Part I. treats of the Metamorphic rocks; Part II. of the Palæozoic strata. This second part is subdivided according to the rocks in the series, and under each rock into State Districts, and it occupies 480 pages of the first volume and 665 of the second. The second volume commences with the coal basins of the State, to which over 600 pages are devoted. Part III, some 30 pages in length, takes up the Mesozöic Red sandstone series, of the age of the Connecticut River Sandstone. Part IV. includes discussions of various subjects: (1) the igneous rocks and minerals, veins and ores; (2) the conditions of the physical geography attending the production of the Palæozoic strata of the United States; (3) the organic remains of the State; (4) the laws of structure of the more disturbed zones of the earth's crust; (5) classification of the several types of orographic structure illustrated in the Appalachians; (6) coal fields of the United States and British Provinces; (7) chemical constitution and physical characters of the best known coals of North America; (8) British coal-fields; (9) composition and varieties of coal; (10) methods of searching for, opening and mining coal, pursued in Pennsylvania; (11) American and European coal-fields and coal trade; (12) statistics of the iron trade.

The subject of greatest scientific interest, and that which, apart from the coal itself, is most fully illustrated, is that of the structure of the Appalachians, including the system of folds constituting the great range of mountains and the arrangement of the ridges. The facts bear on the history of all mountain making. A large number of sections illustrating this subject are contained in the second volume. We like the facts far better than the theory adopted to account for them.

The subject of coal is treated from every point of view, topographical, geological, economical, and commercial. A fine large map of the anthracite coal-fields accompanying the work is by Peter Lesley, Esq., of the geological corps connected with the survey.

The work is deficient, as the author acknowledges, in the department of Palæontology. As regards the coal plants, Prof. Rogers was fortunate in having the coöperation of Leo Lesquereux, to whose labors the work is indebted for descriptions of a large number of coal plants and a series of excellent plates illustrating them. The zoological palæontology Prof. Rogers has not undertaken to describe. A few figures are given in the chapter on organic remains, pp. 815 to 829; but they are very unsatisfactory, and are sometimes wrongly named or without any specific names.

The author has left this great department of the survey to future workers. This being so, the author had hardly a broad enough basis for the institution of a new system of nomenclature and of subdivisions for the Palæozoic formations, and especially for diverging in these respects from the New York survey, in which the subdivisions had been founded upon a thorough study of the organic remains. The names of these subdivisions, Auroral, Matinal, Levant, Surgent, and so on, can not be proved to be better than those before adopted. They are founded on the idea of a Palæozoic day, which has had no existence except in the fancy of the writer. This unfortunate framework, about which Prof. Rogers has clustered his facts, is no serious impediment to the geological reader who has a key at hand for comparison.

The work is a great one, worthy of the state which authorized the survey. It contains a vast amount of information in all its departments, and will ever rank among the most important of the reports on the geology of the United States. A large and beautiful geological map of the State accompanies it.

6. *Contributions to the History of Euphotide and Saussurite;* by T. Sterry Hunt (this Journal, [2], xxvii, 336–347).—*Erratum.*—On page 345 in the analysis of saussurite VI. the oxygen of 27·72 of alumina is given as 13·95 instead of 12·95, the true number. This correction being made, the oxygen ratios for the protoxyds, sesquioxyds and silica become 7·62 : 13·73 : 23·25, equal to 1 : 1·80 : 3·05, instead of 1 : 1·93 : 3·05. In this case therefore as well as in analysis VII, there is present a certain excess of protoxyds and silica, corresponding nearly to a tersilicate.

T. S. H.

7. *Cretaceous of New Jersey.*—In the note to page 88 of this volume, it is intended to say, that the fossil leaves of New Jersey were found in the lower part or base of the Cretaceous formation in that state, that is, beneath an extensive range of strata containing acknowledged Cretaceous fossils.

8. *Report of the Exploration of the Country between Lake Superior and the Red River Settlement, and between the latter place and the Assiniboine and Saskatchewan;* by S. J. Dawson, Esq., C. E. 45 pp. 4to. Toronto, 1859. Printed by order of the Legislative Assembly.—Besides important information on the geography of the region referred to, some geological facts of interest are brought out. The Cretaceous formation is shown to occur at a point on the Assiniboine, 150 miles west of Fort Garry. The fossils were sent to Messrs. Meek and Hayden for their opinion; and they state that among them there is an *Ammonites placenta*, a fragment of what was probably an *Inoceramus;* and an *Ostræa* near *O. congesta*. The Ammonite was received from an Indian; the latter two were from a dark shale in situ on the Assiniboine, containing fish scales, and closely resembling the Cretaceous beds No. 2 of Nebraska in Meek and Hayden's section. It is suggested that the Ammonite might have been carried north by the Indians, but in view of the other facts it is improbable. Another lot of specimens, including *Scaphites Nicoletii* and *Nautilus DeKayi*, received from another person, is said to have been found in the bed of the Saskatchewan.

9. *On the Fossil Corals of the Devonian Rocks of Canada West;* by E. BILLINGS, F.G.S. 44 pp. 8vo. (From the Canadian Journal for March, 1859.)—This paper by Mr. Billings contains notices of forty-three species of Devonian corals. He observes that about fifty species are known to occur in the rocks, but a few of them in specimens too imperfect for description. Six of these, he states, are found in the Devonian of Europe, viz. *Favosites gothlandica*, *F. basaltica*, *F. cervicornis*, *F. polymorpha*, and *Heliophyllum Halli*. All but two of the species come from the Corniferous and Onondaga limestones. The paper is illustrated by twenty-nine figures.

10. *On some new Genera and Species of Brachiopods from the Silurian and Devonian Rocks of Canada;* by E. BILLINGS (Rep. Canada Geol. Survey, 1858).—This paper describes and illustrates by figures two genera, *Centronella* and *Stricklandia*. The first includes the *Rhynchonella glans-fagi* of Hall, from the Oriskany sandstone and Corniferous limestone in Canada, and Schoharie grit in New York. It has a loop, like Terebratula; the loop consists simply of two slender lamellæ which extend about one-half the length of the shell, where they unite at an acute angle and then become reflexed towards the beak as a thin plate. The genus *Stricklandia* includes the *Pentameras lens*, *P. liratus*, and *P. lævis* of the Middle Silurian of Britain. Three new species are described; *S. gaspiensis*, *S. canadensis*, and *S. brevis*, all from the Upper or Middle Silurian.

11. *Reports on the Geology, Botany and Zoology of Northern California and Oregon;* made to the War Department by JOHN S. NEWBERRY, M.D., Prof. Geol. and Chem. Columbian College, Washington, D. C. 320 pp. 4to, with numerous plates. Washington.—The Geological and Botanical Reports of Dr. Newberry, noticed in our last volume at page 123, are here collected together and published as a separate volume. On the importance and value of the researches we have already remarked. This fine volume contains, besides the geological and botanical reports, a Zoological Report, including a Report on the Fishes collected on the Survey by Dr. C. Girard; on the Zoology of the route by J. S. Newberry; on the Land Shells by W. G. Binney; and on the Reptiles by S. F. Baird; and there are numerous plates of fossils, plants, fishes, reptiles, quadrupeds, and birds.

12. *Geological Excursion.*—Col. E. Jewett of the N. Y. State Geological Museum, Albany, will make an excursion over the State of New York with such students as may choose to join him, in the course of the month of August. The party will leave Burlington, Vt., on the first Monday of August, visit Keeseville and other localities of the lowest Silurian, Montreal, Niagara Falls, Rochester and Genesee Falls, Syracuse, Utica and Trenton Falls, Schoharie, etc., and be out in all about forty days. Col. Jewett's charges are forty dollars for each student, the student bearing his own expenses. It is an excellent opportunity for any who wish to study geology in the field.

III. ASTRONOMY.

1. *Comets of* 1858.—During the year 1858 eight comets were observed. The 1st was discovered by *Tuttle* of Cambridge, Mass., Jan. 4, 1858, the 2d by *Winnecke* of Bonn, March 8, the 3d by *Tuttle*, May 2, the 4th by *Bruhns* of Berlin, May 21, the 5th (the great comet) by *Donati* of Florence, June 2, the 6th was Encke's comet on its return, the 7th was Faye's comet on its return, the 8th was discovered by Tuttle, Sept. 8.

2. *First Comet of* 1859.—This comet was first detected on the 2d of April, 1859, by Mr. Tempel at Venice. Its approximate place at $8^h\ 15^m$ April 2, was R. A. $14^h\ 30^m$, N. Decl. 71°.

3. *Numbering of the Planetoids or Asteroidal Planets.*—In numbering the planetoids a difficulty has arisen from the fact discovered by Mr. Schubert, that the planetoid detected by Mr. Goldschmidt, Sept. 9, 1857, and mistaken for *Daphne*, is undoubtedly a different body. In the *Annuaire* for 1859 of the French Board of Longitude, the planetoid detected Sept. 9, 1857, is numbered (47), and the numbers of all those subsequently discovered is increased by *one*. Mr. LeVerrier objects to this proceeding, on account of the confusion which it occasions, and maintains that the planetoid of Sept. 9, 1857, should be numbered (56).

Which plan will finally be adopted by astronomers remains to be seen. We incline to that of the Annuaire, as strictly conformed to the old rule of numbering in the order of discovery, and as likely on the whole to produce the least confusion.

IV. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Marcou's Strictures on North American Geologists.*—Mr. Marcou has issued a pamphlet of 40 pages, purporting to be a reply to the two articles on his North American Geology by James D. Dana. These two articles he has cited at length, and something more; for in the second, he has inserted, without any notice of it, nearly a page of matter from his book which the reviewer did not quote. The pamphlet presents no new basis for his claims, and calls for no reply. We merely quote a single paragraph for remark, as it has an editorial bearing. It is introduced after citing Prof. Agassiz's article from page 134 of our last volume, and is as follows:

> "Mr. Dana's love of the *truth* and *duty to science* obliged him to decline publishing this article in my favor without alterations, which the author refused to make, not wishing to pass under Mr. Dana's editorial scissors; and Mr. Agassiz was obliged to threaten the withdrawal of his name from the *Journal* to induce Mr. Dana to modify his views of duty sufficiently to publish the article as it was written."

There was no refusal on the part of Mr. Dana to publish Professor Agassiz's reply, and no proposition for editorial curtailment, but only objections to its views, and a request to delay the publication, because Prof. Agassiz had not yet read the book under review, and therefore did not know what it contained and could not properly, Mr. Dana thought, write a reply to a review of it. Moreover, when Prof. Agassiz insisted upon publishing (trusting to his knowledge of Mr. Marcou's former publications), he at the same time stated that he had not the least objection to Mr. Dana's following him with his criticisms. The sequel has shown

the propriety of Mr. Dana's natural suggestion, and enables us to state, on the best of grounds, that if Prof. Agassiz had known what was in the book in question he would not have written at all. Up to the day of Prof. Agassiz's departure for Europe there has been no interruption of the cordial intercourse that has always subsisted between him and Mr. Dana; and we are confident that if he had not left the country immediately after the arrival of the pamphlet, he would himself have made a statement similar to this, in his own name.—EDS.

2. *Auroral Arch.*—During the display of the aurora borealis seen here on the evening of Friday, April 29, 1859, a well defined luminous arch or belt sprung up, spanning the sky from the western horizon nearly over to the eastern, and passing a little south of our zenith. This was its appearance at $8^h\ 53^m$, when it was fully formed. Ten or fifteen minutes previous it was not visible, and I did not observe the process of formation. Its width was from five to six degrees in the meridional portion, but was not quite uniform or constant throughout its whole extent, and the northern edge was best defined. The westerly portion swung slowly southward while the part for twenty degrees or more about the meridian changed its place so little and so slowly, as to present an uncommonly good opportunity for fixing its place among the stars, and to render exact accuracy in time less important. At $8^h\ 58^m\ 0^s$, New Haven mean time, the central line of the arch was almost precisely on δ *Leonis*, and so continued for about five minutes. Soon after this, it sailed about three degrees southward, so that the arch was just comprised between δ and θ *Leonis*. By $9^h\ 18^m$ it had drifted back and δ was again very near the middle line of the arch. The phenomenon gradually faded from the east westwardly, and by $9^h\ 38^m$ all had vanished. During this whole time the sky was clear and there was no secondary arch to embarrass the observer.

It is greatly to be desired that these and other data secured here may be united with like observations made to the north and south of New Haven, in order to determine the altitude and width of the arch. Through the kindness of Professor Loomis a few have reached me, but they are too indefinite to be useful in this respect. Loose observations at Suffield, Conn., combined with those made here seem to indicate a height of much more than 100 miles. Any one within 300 miles of this place who may have any tolerable observations on the arch is earnestly desired to publish them in this Journal, or to send them to me. E. C. HERRICK.

New Haven, Conn.

3. *On Apparent Equivocal Generation;* by H. JAMES CLARK, of Cambridge, Mass. (From the Proceedings of the American Academy, Boston, May 10th, 1859).—At the close of our last social meeting I was asked if I had seen any trace of organization in the globules of the Vibrio-like fibrillæ of the muscle of Sagitta. (See p. 108 of this number). My answer was in the negative. No longer ago than yesterday I was fortunate in discovering the origin of another, or rather of several forms of these pseudo-animate bodies called Infusoria. Whilst watching the decomposition of the inner wall of the proboscis of a young *Aurelia flavidula*, our common jelly-fish, I observed that the whole component mass of cells was in violent agitation, each cell dancing zigzag about

within the plane of the wall. If any one will shake about a single layer of shot in a flat pan he can obtain an approximate idea of the appearance of this moving mass. In a perfectly healthy condition these cells lie closely side by side, and do not move individually from place to place, but yet are active on one side, which constitutes the surface of the stomach, where they are covered by vibratile cilia. As the young Aurelia grows, this wall becomes separated from the outer one, but not completely, for the cells of the two adhere to each other by elongated processes varying in number from one to six or seven. Each cell of the inner wall contains numerous red or brown granules, a few transparent globules, and a single large clear mesoblast. When decomposition ensued, these cells became still farther separated from each other and danced about in the manner which I have just described. The vibratile cilia were not observed to share in this movement; in fact I could not detect their presence, because, no doubt, they had become decomposed and fallen away; but the elongated processes, which heretofore had remained immovable and stiff, lashed about with very marked effect upon the cells to which they belonged, and caused them to change place constantly. At last the inner wall fell to pieces and every cell moved independently and in any direction. If at this time they were placed before the eyes of Ehrenberg or any one of his adherents, he would at once pronounce every cell with a single process a *Monas;* the red or brown granules would be recognized as the stomachs filled with food, the transparent globules as the empty stomachs, and the large mesoblast as the genital organ or propagative apparatus. Those with two processes would be to him a *Chilomonas* or some other genus closely related to it; those with three or four on one side would be the *Oxyrrhis* of Dujardin; and those with six or seven processes the *Hexamita* of the same author. To complete the apparently truthful determinations of these microscopists I would only have to place before them some of these cells which I have found in a state of self-division, each half possessing its genital-like mesoblast. In all their various shapes and actions, and in the mode of self-division there is a remarkable and undistinguishable resemblance to numerous moving bodies which go under the name of Infusoria, and which may be found, unconnected with any living organism, in various kinds of infusions.

4. *Note on the Polarization of the Light of Comets;* by Sir David Brewster, (L., E. and D. Phil. Mag., April, 1859, p. 311).—Although there can be no doubt as to the accuracy of the observations of M. Arago on the indications of polarization discovered by him in the light of the comets from 1819 to 1835, there is nevertheless nothing impossible in the supposition that the light may have been polarized after arriving in the terrestrial atmosphere. In fact, when we consider that light is polarized by refraction in passing through the coats of the eye, that it is polarized by refraction at the four or six surfaces of the object-glasses of an astronomical telescope, and also in passing through the surfaces of its eye-piece, and, lastly, that the light of celestial bodies undergoes a slight polarization by the refraction of the atmosphere, we are compelled to admit that the problem of the existence of polarized light in the light of comets is not solved.

I am not aware that those who have observed traces of polarization in the light of comets have noted the direction of the plane in which it has been polarized; nevertheless without some such observation we cannot discover its cause. If the light be polarized in a plane passing through the sun, the comet, and the eye, we must infer that it is polarized by the *reflexion* of the light coming from the sun; if it be polarized in an opposite plane, the polarization may be due to the *refraction* of the atmosphere. If it be polarized *quaquaversus*, this may be due to three causes; namely, to refraction by the surfaces of the object-glasses and eye-piece, to an imperfection in the annealing of the glass of which the lenses are formed, or to the fact of one or more of the lenses being pinched in their cell. Supposing it to be an effect of the first of these causes, the openings of the object-glasses and eye-piece should be reduced to a central band, which would eliminate the light polarized in an opposite plane, and leave that which is polarized in a plane perpendicular to the direction. By turning the telescope or the lenses, the direction of the polarization would be changed.

If the polarization be produced by a defect in the annealing of the glass of which the lenses are made, as appears to be the case in one of Amici's telescopes mentioned by M. Govi, the existence of this imperfection will be rendered evident by exposing the lenses to polarized light.

If the polarization observed be due to the reflexion of the rays of the sun by the comet or its envelops, small stars will be seen more distinctly through it when the polarized light is extinguished by the application of a Nicol's prism.

Whilst I was investigating the polarization of the atmosphere, I observed the remarkable fact, that when objects situated far off in the open country are rendered indistinct by the interposition of a light mist, a part of their distinctness may be restored by viewing them through a Nicol's prism, which extinguishes all the light polarized by the mist in a plane passing through the sun, the object, and the eye of the observer. The objects thus rendered more distinct and visible were seen through that portion of the mist in which the polarization of the light reflected by them was at its maximum. This method of rendering visible objects rendered indistinct by fogs or mists may, it appears to me, receive important applications in military and naval operations.—*Comptes Rendus*, February 21, 1859, p. 384.

5. *The Iron Manufacturer's Guide to the Furnaces, Forges and Rolling Mills of the United States*, with discussion of iron as a chemical element, an American ore, and a manufactured article, in Commerce and in History; by J. P. Lesley, Sec'y of the American Iron Association, and published by authority of the same, with maps and plates. New York: John Wiley, Publisher. London: Trubner & Co. 1859. 8vo, pp. 766.—Mr. Lesley has here done a service which will be highly appreciated by all who know the national importance of the iron industry, as well as by those whose researches lead them to seek in a compendious form all the information on subjects connected with iron, to find which they have hitherto been forced to search through a wilderness of isolated authorities. Being a good geologist, familiar with the geology of Pennsylvania

and practically acquainted with what relates to the subject of iron, he was eminently fitted for the labor he has here performed. The work is divided naturally into two parts. The first is a "Directory to Iron works" in the U. S.; Furnaces and Forges and Rolling Mills. The second part (from the 264th page to the end) is a "Guide to the ores," embracing first, general considerations respecting iron as an element, and next, its ores in the United States.

In both divisions of his work Mr. Lesley has adopted a geographical order as the basis of his arrangements, subdividing the matter however according to subjects. Then in his Directory he tabulates, under the letter A, 120 anthracite blast furnaces in the U. S., of which he gives such particulars about each as are most important to be known. Tables B, E, H, K, enumerate with concise descriptions 650 charcoal furnaces, including also a few (less than 20) raw coal furnaces. Tables C, F, and I comprise the bloomeries and forges in the U. States to the number of 497. Tables D, G, J, are devoted to the rolling mills of the U. States, 224 in number. From a valuable statistical summary in the end of the volume we draw the following facts.

The entire production of raw metal in the U. S. in 1856 was a little over eight hundred thousand tons (812,917 tons), being an increase of 12 per cent from 1854. For the year 1856 the whole iron production advanced only 6 per cent over the previous year, but the anthracite branch of the manufacture reached the aggregate of 394,509 tons, being nearly one-half the whole iron product of the country, and showing an increase of *thirteen per cent* over the previous year, a fact to be explained by the conversion of charcoal furnaces into anthracite furnaces. The industry naturally tends to concentrate itself about the geological centre of fuel in Pennsylvania, a fact shown by the decline of this branch of the iron industry outside of Pennsylvania by an annual rate of over six per cent, which raises the Pennsylvania anthracite annual increase to over *twenty-two per cent.*

The commercial crisis of 1857 has been seen in a most serious falling off in the iron product of 1858, consequent on the sudden arrest of so large a number of railways in progress of construction.

The grand total of iron of all kinds, domestic and foreign, used in the United States in 1856 is set down at 1,330,548 tons, which is distributed thus:

	Domestic.	Foreign.	Total.
Rolled and hammered,	519,081	298,275	817,356
Pig iron,	337,154	55,406	392,557
	856,235	353,678	1,209,913

which results give 70 per cent *domestic* to 30 per cent *foreign* iron. The great fact demonstrated by the statistics collected by the American Iron Association are that we have nearly 1,200 efficient iron works in the U. S., producing annually about 850,000 tons of iron, the value of which in an ordinary year is fifty millions of dollars, of which the large sum of $35,000,000 is expended for labor alone.

Mr. Whitney, in his Metallic wealth of the United States, estimates the iron product of the world at 5,817,000 tons, of which 1,000,000 are set down for the U. S., Great Britain producing that year 3,000,000.

When we remember that so late as 1845 the total product of the United States in iron had not reached half a million tons (486,000) and that in 1850 it was only 600,000 tons, it will be seen that the progress in this important industry in the first six years of this decade has been at the rate of over twenty per centum per annum. The operation of this law of increase will soon, it would seem, put an end to all importation of iron, and points even to an export of this great staple at no distant day. The stock and variety of iron ores and coal in the United States is such as seems adequate to meet the demands of the world as fast as the laws of commerce will permit their development.

6. *Mammals of North America:* the descriptions of species based chiefly on the collections in the Museum of the Smithsonian Institution; by SPENCER F. BAIRD, Assistant Secretary of the Smithsonian Institution. 764 pp., 4to, with 87 4to plates of original figures, illustrating the Genera and Species, and including details of external form and osteology. Philadelphia, J. B. Lippincott & Co. 1859.—Professor Baird has here placed before the country a comprehensive Treatise on the Mammals or Quadrupeds of the country, well illustrated by plates. And from the collections under the author's hands, and our knowledge of his care and ability, we are sure that we now have one branch of American zoology thoroughly discussed. The first part of this volume has already been noticed in this Journal (vol. xxvi, 142), it consisting of the Report on Mammals in the Pacific Railroad Survey. To this is added the Report on the Mammals of the United States and Mexican Boundary Survey. The descriptions are given with full details, and in the plates there are illustrations relating to 161 species. The libraries of the country should be supplied with this great work.

7. *Rational Cosmology, or the Eternal Principles and the Necessary Laws of the Universe;* by LAURENS P. HICKOK, D.D., Union College. New York, 1858.—Rational cosmology comes reasonably within the range of this Journal, but not the system of Prof. Hickok, which is decidedly irrational. He claims to educe a philosophy of nature from the empty reason instead of through induction, and has proved the fallacy of the method by educing laws that are not the laws of nature. The author, unwittingly, drew upon the furniture of his own mind, unaware that it was defective and had been derived by imperfect reason from the base earth. Prof. Alexander of Princeton has well set forth the errors of the "Rational Cosmology" in the Princeton Review for April, 1859; and we would commend the article to all interested in the subject. The laws of nature when fully learned and understood will appear to the reason like the evolution of one thought. But reason should not deceive itself and suppose, because it can perceive this unity, that it can therefore evolve of itself the thought and the system of laws.

8. *American Association for the Advancement of Science.*—The next meeting of the Scientific Association was appointed to be held at Springfield, Mass., commencing with the first Wednesday of August. Prof. Stephen Alexander of Princeton is President for the year, and Prof. Edward Hitchcock Vice-President.

9. *Synopsis of the Fresh-water Fishes of the Western Portion of the Island of Trinidad, W. I.;* by THEODORE GILL. 70 pp. 8vo. H. Bailliere, New York City. (From the Annals of the Lyceum of Natural History, New York, Vol. VI.)

10. *Notes on North American Crustacea,* No. I.; by WM. STIMPSON. 48 pp. 8vo, with 1 plate (from the Annals of the Lyceum Nat. Hist. of New York for March, 1858).—We have barely space to announce the appearance of this first part of a systematic account of North American Crustacea. It commences with the Maioids and closes with the Pagurus family among the Anomoura.

JAMES D. FORBES: Occasional papers on the theory of glaciers, now first collected and chronologically arranged with a prefatory note on the recent progress and present aspect of the theory. 278 pp. Edinburgh, 1859. A. & C. Black.

R. I. MURCHISON: Siluria; the History of the oldest fossiliferous rocks and their foundations, with a brief sketch of the distribution of gold over the earth. 3d edition. London, 1859. Murray.

Rev. JOHN FLEMING: The Lithology of Edinburgh. Edinburgh.

C. M. TRACY: Studies of the Essex Flora; a complete enumeration of all plants found wild within the limits of Lynn, Mass., and the towns adjoining. 88 pp. 8vo. 1858.

PROCEEDINGS BOSTON SOC. NAT. HIST. 1859.—p. 17, Birds of Florida, continued; *Dr. H. Bryant.*—p. 21, Distribution and habits of the Summer Yellow-bird; *Dr. Brewer.*—p. 22, Minerals of the gold region of Georgia; *C. T. Jackson.*—p. 23, On some new Actinoid Polyps of the Coast of the United States; *Agassiz.*—p. 26, Diatoms of West Roxbury; *C. Stodder.*—p. 28, A new Helix from Maine; *T. J. Whittemore.*—p. 29, On the corrosive properties of guano; *C. T. Jackson.*—p. 31, Origin of the Copper and Silver of the Lake Superior region; *C. T. Jackson.*—p. 33, Menobranchus in the Mohawk River; *J. Lewis.*—p. 34, Note on species of Pomotis; *F. W. Putnam.*—p. 38, On the recent eruption of Mauna Loa; *H. M. Lyman.*—Descriptions of new shells; *A. A. Gould.*—p. 45, Note on minerals formed from springs; *C. T. Jackson.*—p. 47, Note on thickness of the earth's crust; *W. B. Rogers.*—p. 48, Tuckahoe contains no starch; *C. T. Jackson.*

PROCEEDINGS ACAD. NAT. SCI. PHILADELPHIA, 1859.—p. 91, Tooth of a Mastodon from Honduras, probably of the same species as the common U. S. Mastodon; also on Mosasaurus bones from New Jersey; *J. Leidy.*—p. 93, On the species of Nicotiana; *J. LeConte.*—p. 98, Notes on Coluber calligaster of Say; *R. Kennicott.*—p. 100, Ichthyological Notices; *C. Girard.*—p. 104, Catalogue of birds of New Mexico; *T. C. Henry.*—p. 110, Teeth of reptiles and other fossils in the Triassic of Pennsylvania; teeth near those of Saurichthys and others of Diplodus from a locality at Bethany in Virginia; teeth of Pycnodus, Otodus and Galeocerdo, palate and teeth of Pycnodus and fragments of jaws of Mosasaurus from the Green Sand of Monmouth Co., N. J.; *J. Leidy.*—p. 111, Sombrero guano; skull of Ursus Americanus, associated with bones of Mastodon at Oxford, Miss.; *J. Leidy.*—Eight new species of Unionidæ; *I. Lea.*—p. 113, Ichthyological notices; *C. Girard.*—p. 122, On the primary divisions of the Salamandridæ; *E. D. Cope.*—p. 128, On the genus Callionymus of Authors; *T. Gill.*—p. 131, Description of Hyporhamphus, a genus of fishes allied to Hemirhamphus; *T. Gill.*—p. 132. On Dactyloscopus and Leptoscopus, two genera of the family of Uroscopidæ; *T. Gill.*—p. 133, Catalogue of Birds collected in Western Africa by P. B. Duchaillu; *J. Cassin.*—p. 144, Notes on a collection of Japanese Fishes; *T. Gill.*—p. 151, Descriptions of twelve new species of exotic Unionidæ; *I. Lea.*—p. 154, Descriptions of new species of Uniones from Georgia and other Southern States; *I. Lea.*—p. 155, Description of a third genus of Hemirhamphinæ; *T. Gill.*—p. 157, Ichthyological Notices; *C. Girard.*

Bibliographical Notices by Prof. Nicklès.

MALLET & BACHELIER of Paris offer the following works:

Treatise on Optical Physics, by Billet, Professor of Physics in the Scientific Faculty of Dijon. Vol. II.—We have already announced Vol. I. of this remarkable

work, which embraces all that relates to the higher optics, to which M. Billet has devoted himself. Vol. II. is quite as important and instructive. The labors of Thomson, Young, and Fresnel have contributed most of the material.

Photographic Chemistry, by Barreswill and Davanne, in 8vo, 2d edition.—Within a few years the first edition of this work, announced by us, has been exhausted and a second edition rendered necessary. The authors have introduced into it all the latest improvements, and it contains many unpublished facts. Following the progress in photography, they have attached great importance to the processes on collodion and on paper, and placed the daguerrotype in the second rank.

Aluminium, its nature, manufacture and applications, by H. St. Claire Deville, in 8vo, 176 pages, with plates.—This important work has been mentioned in our communication on page 126. It contains the whole history of the subject, and communicates many interesting details. Notwithstanding that the French government and private individuals have contributed to the researches on aluminium, Deville informs us that he has sacrificed to it a large part of his personal fortune.

Physiological investigations on the animalcules of vegetable infusions compared with the elementary organisms of plants, by Paul Laurent, inspector of forests, &c. Vol. 2. 4to, with plates. Paris: T. B. Bailliere.—We have announced Vol. 1, which appeared in 1854. This volume, in which micrographic observations play so important a part, treats especially of the elementary organisms of plants. Paul Laurent was for thirty years professor in the forest school of Nancy; he has trained many pupils, and some of them are, like himself, devoted to microscopic studies.

Scientific Essays, by Victor Meunier, in 12 nos. of 212 pages. Vol. 3d.—We have already spoken of this work of popular science, devoted especially to inventions and discoveries which have not been made by those who were properly scientific men. The weekly journal, L'Amis des Sciences, by the same author, is devoted to the same end. It happens at the present moment, that this journal has entered into the great contest between pan-spermists and hetero-genists, and favors the theory of spontaneous generation. Victor Meunier is otherwise a competent man, and was the favorite pupil of the great naturalist Stephen Geoffroy Saint Hilaire.

The Moniteur des Hospitaux.—Medico-Surgical Review of Paris.—This journal, which appears three times a week, is one of the most celebrated medical periodicals of Paris. Its chief editor, N. de Castelnau, occupies an eminent rank in medical criticism. Every week this journal presents a critical "fenilleton" entitled "medical darts," in which the editor, Dr. Toulin, with great spirit attacks charlatanism in matters of medicine and pharmacy, as well as whatever is absurd in cotemporary physicians.

Annals of the Paris Observatory, published by Leverrier. Vol. 4, in 4to. Paris: Mallet & Bachelier.—This important volume is devoted to the theory and to tables of the apparent motion of the sun; it is entirely from the hand of M. Leverrier, who has impressed it with the stamp of his own genius.

Catalytic Force, or Investigations on the Phenomena of Contact, by T. L. Phipson. A pamphlet in 4to of 34 pages.—This work was crowned by the Holland Society of Sciences in 1858. The author examines with much care the phenomena called catalytic; he explains these phenomena on a ground-work of known facts, and he concludes that catalysis exists only in name, and that the force known under the name is a pure fiction.

THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

7.7.

ART. XVII.—*Obituary Notices of Brown and Humboldt, Members of the American Academy of Arts and Sciences;* from the Report of the Council of the Academy for 1859.

(Proceedings of the Academy, vol. iv, p. 229 et seq.)

BEYOND the immediate pale of science, and the circle of its most devoted cultivators, the association of the names of HUMBOLDT and BROWN may seem new and strange;—the one, a name familiar to the whole civilized world; the other, hardly known to a large portion of his educated countrymen. Yet these names stand together, in the highest place, upon the rolls of almost every Academy of Science in the world; and the common judgment of those competent to pronounce it will undoubtedly be, that although these vacant places upon those honorable rolls may be occupied, they will not be *filled*, in this, perhaps not in several generations.

Upon the death of ROBERT BROWN, which occurred on the 10th of June last, in his eighty-fifth year, it was remarked that, next to Humboldt, his name adorned the honorary list of a greater number of scientific societies than that of any other naturalist or philosopher. It was Humboldt himself who, many years ago, saluted Brown with the appellation of *Botanicarum facile Princeps;* and the universal consent of botanists recognized and confirmed the title. However the meed of merit in science should be divided between the most profound, and the most active and prolific minds,—between those who *divine* and those

who *elaborate*,—it will probably be conceded by all, that no one since Linnæus has brought such rare sagacity to bear upon the structure, and especially upon the ordinal characters and natural affinities of plants, as did Robert Brown. True, he was fortunate in his time and his opportunities. Men of great genius, happily, often are, or appear to be, through their power of turning opportunities to good account. The whole herbaria of Sir Joseph Banks, and the great collections which he himself made around the coast of Australia, in Flinder's expedition, and which he was able to investigate upon the spot during the four years devoted to this exploration, opportunely placed in Brown's able hands as it were the vegetation of a new world, as rich as it was peculiar,—just at the time, too, when the immortal work of Jussieu had begun to be appreciated, and the European and other ordinary forms of vegetation had begun to be understood in their natural relations. The new, various, and singular types which render the botany of New Holland so unlike all other, Mr. Brown had to compare among themselves,—to unravel their intricacies with scarcely a clew to guide him, except that which his own genius enabled him to construct in the process of the research,—and to bring them harmoniously into the general system of botanical natural alliance as then understood, and as he was himself enabled to ascertain and display it. It was the wonderful sagacity and insight which he evinced in these investigations, which, soon after his return from Australia, revealed the master mind in botanical science, and erelong gave him the position of almost unchallenged eminence, which he retained, as if without effort, for more than half a century.

The common observer must wonder at this general recognition, during an era of great names and unequalled activity, of a claim so rarely, and as it were so reluctantly, asserted. For brief and comparatively few—alas! how much fewer than they should have been!—are Mr. Brown's publications. Much the largest of them is the Prodromus of the Flora of New Holland, issued fifty years ago, which begins upon the one hundred and forty-fifth page, and which stopped short at the end of the first volume. The others are special papers, mostly of small bulk, devoted to the consideration of a particular plant, or a particular group or small collection of plants. But their simple titles seldom foreshow the full import of their contents. Brown delighted to rise from a special case to high and wide generalizations; and was apt to draw most important and always irresistible conclusions from some small, selected data, or particular point of structure, which to ordinary apprehension would appear wholly inadequate to the purpose. He had unequalled skill in finding decisive instances. So all his discoveries, so simply and quietly announced, and all his notes and observations, sedulously

reduced to the briefest expression, are fertile far beyond the reader's expectation. Cautious to excess, never suggesting a theory until he had thoroughly weighed all the available objections to it, and never propounding a view which he did not know how to prove, perhaps no naturalist ever taught so much in writing so little, or made so few statements that had to be recalled, or even recast; and of no one can there be a stronger regret that he did not publish more.

With this character of mind, and while carefully sounding his way along the deep places of a science the philosophy and grounds of which were forming, day by day, under his own and a few contemporary hands, Brown could not have been a voluminous writer. He could never have undertaken a *Systema Regni Vegetabilis*, content to do his best at the moment, and to take upon trust what he had not the means or the time to verify,—like his contemporary, DeCandolle who may worthily be compared with Brown for genius, and contrasted with him for the enthusiastic devotion which constantly impelled him to publication, and to lifelong, unselected, herculean labor, over all the field, for the general good.

Nor could Brown ever be brought to undertake a *Genera Plantarum*, like that of Jussieu; although his favorable and leisurely position, his vast knowledge, his keen discrimination, and his most compact mode of expression, especially indicated him for the task. Evidently, his influence upon the progress of Botany might have been greater, or at least more immediate and more conspicuous. Yet, rightly to estimate that influence now, we have only to compare the *Genera Plantarum* of Endlicher with that of Jussieu,—separated as they are by the half-century which coincided with Brown's career,—and mark how largely the points of difference between the two, so far as they represent inquiry, and genuine advancement in the knowledge of floral structure, actually originated with him. Still, after making due allowance for a mind as scrupulous and cautious as it was clear and profound, also for an unusually retiring disposition, which even in authorship seems to have rendered him as sedulous to avoid publicity as most writers are to gain it, it must be acknowledged that his retentiveness was excessive; and that his guarded published statements sometimes appear as if intended—like the anagrams of the older mathematicians and philosophers—rather to record his knowledge than to reveal it. But this was probably only in appearance, and rather to be attributed to his sensitive regard for entire accuracy, and his extreme dislike of all parade of knowledge,—to the same peculiarity which everywhere led him to condense announcements of great consequence into short paragraphs or foot-notes, and to insert the most important facts in parentheses, which he who runs over the page may read, indeed,

but which only the most learned and the most reflecting will be apt to comprehend. In candor it must be said, that his long career has left some room for the complaint that he did not feel bound to exert fully and continuously all his matchless gifts in behalf of the science of which he was the most authoritative expositor.

But if thus in some sense unjust to himself and to his high calling, Brown could never be charged with the slightest injustice to any fellow-laborer. He was scrupulously careful, even solicitous, of the rights and claims of others; and in tracing the history of any discovery in which he had himself borne a part, he was sure to award to each one concerned his full due. If not always communicative, he was kind and considerate to all. To adopt the words of one of his intimate associates, "those who knew him as a man will bear unanimous testimony to the unvarying simplicity, truthfulness, and benevolence of his character," as well as to "the singular uprightness of his judgment."

The remaining, and the most illustrious name of all,—and one in its wide renown strongly in contrast with the last,—has only just now been inscribed upon our obituary list.

The telegraph of the last week brought to us the painful intelligence that the patriarch of science, the universal HUMBOLDT, died at Berlin on the 6th of May. Born in 1769, a year more prolific in great men than any equal period of all preceding time,* Humboldt had, before the end of the eighteenth century, exhibited qualities of the very highest order, and obtained a place of acknowledged celebrity in Europe. This, however, was the mere prelude to his career, for with the close of that century he commenced, with Bonpland, his wonderful exploration of Spanish America, which continued during five years. This journey must be considered in all future time as, substantially, the scientific discovery of Spanish America; and whether we measure its results by the amount of knowledge through the wide fields of Astronomy, Geography, Geology, Mineralogy, Meteorology, Zoology, Botany, and Political Economy, or the personal qualities by which this knowledge was collected and reduced to its place in the records of science, we cannot hesitate to rank the expedition amongst the most important and successful ever executed by man.

On his return to Europe, in 1805, Humboldt was employed several years in reducing his immense collection of materials to form for publication. From that time to his death, a period of almost half a century, he resided (except for a short time, in

* Napoleon, Wellington, Mehemet Ali, Soult, Lannes, Ney, Castlereagh, Chateaubriand, Cuvier, and Humboldt. [The name of Metternich is sometimes added to this list, probably incorrectly. That of Canning certainly does not belong here, nor that of Mackintosh, nor of Sir Walter Scott.—EDS.]

which he made his journey to Northern Asia) in Europe, mostly in France and Germany. The last twelve or fifteen years of this great man were principally employed in the production of his *Cosmos*,—the crowning labor of his long life, the harvest of his mature wisdom,—a work that could not have been produced by any other man, simply because no other man possessed the treasures, or a key to the treasures, of the various knowledge contained in it.

From his return to Europe to his death, he possessed, indisputably, the first place amongst philosophers, for the vast extent of his acquirements. Without doubt, at all times during the present century there have been men much greater than Humboldt in each special department of science, but no one to compare with him in the number of subjects in which he had but few superiors,—no one who could, like him, bring all the sciences into one field of view, and compare them as one whole, through their relations and dependences. It was probably this extent of knowledge that led him to generalization rather than particular discovery; to trace connections and relations, rather than to search for new and minute facts or particular laws; to produce the Cosmos, rather than discover the atomic theory or the cellular formation of organic structures. Many other men have been masters of several specialties. Humboldt alone brought the whole range of the physical and natural sciences into one specialty.

We cannot close this brief notice of the character and career of our illustrious associate without one moment's allusion to his amiable moral nature, his love of justice, and his superiority to all merely personal ends. So strong was his desire to give the influence of his high scientific position to the cause of civilization and the progress of knowledge, by assisting all applicants for his opinion and advice upon scientific subjects, that he permitted a correspondence to be extorted from him which in his last days became a load too great to be borne, and compelled a cry for relief that had hardly subsided when the news of his death reached us.

Such is the faint outline of a man whose name is indelibly written with those who have been most eminent in this wonderful age of scientific activity. The Academy claims the privilege, in common with the learned societies with which he was associated throughout the civilized world, to express its sorrow for his death, and to offer its tribute of honor to his memory.

Art. XVIII.—*On the power possessed by the Larves of various common Flies of consuming, without apparent injury to themselves, the flesh of animals which have died from the effects of Arsenic;* by Frank H. Storer.

Read before the Boston Society of Natural History, January 5, 1859.

Some months since my attention was attracted by finding several living maggots upon the liver of a subject in the stomach of which I had previously detected the presence of arsenic. This, eight days after death. As this liver was found, on analysis, to be saturated with arsenic, a number of experiments were made for the purpose of ascertaining whether the larvæ observed had really been nourished by the poisoned flesh on which they were discovered.

Several living rats having been obtained, they were fed with cake which contained arsenious acid in various quantities. • After eating this they in every case soon died. Their skins having been removed, the carcasses were exposed in a chamber to which flies had free access. In the course of forty-eight hours the bodies of the rats were thoroughly fly-blown, and were soon covered by a multitude of larvæ. Having completely consumed the flesh of the rats—leaving the bones bare, as in the specimen now exhibited to the Society—the maggots concealed themselves in sheltered corners and were converted into chrysalids in due course. These results were constant, having been exactly similar in every instance. Some two dozen or less of these chrysalids being subjected to analysis, metallic arsenic was readily obtained from them. It might be thought that this proves nothing more than that the flesh of the rats contained arsenic, and that, that obtained from the chrysalids had possibly been mechanically attached to the exterior surfaces of the larvæ and not have been swallowed by them. This view would indeed seem to be supported by the fact that—as may be seen in the specimen presented—the surface of the bones from which the flesh has been thus devoured is covered with a white powder which has the appearance of arsenious acid. However this may be, only two alternatives remain if it is not admitted that the arsenic found in the chrysalids had really been assimilated by the larvæ: either the latter must possess an instinct which leads them to reject altogether the poison, or it is excreted by them after injestion. In the lack of any positive knowledge of the condition in which arsenic or other inorganic poison exists when contained in organic tissues, it seems idle to dwell at greater length on this point.

It would have been interesting to have preserved the chrysalids in order to ascertain whether they were capable of metamorphosis, and if so, whether the perfect insect would have been healthy and vigorous. I therefore kept a number of them during two months, at the end of which time they were accidentally lost. None of these underwent any change, while a number of diminutive flies, apparently not ichneūmons, which obtained access to them, died almost immediately, as was supposed from having fed upon them. The chrysalids were however in a perfect state of preservation, being full of pulp, just before they were lost. The empty shells of other chrysalids, which had been formed at the same time as the above, were nevertheless found about the room from time to time within the six weeks following their formation, indicating that some of them had been metamorphosed, as the appearances of these shells were normal and no larvæ other than those which had fed upon the arsenicated specimens had been admitted to the apartment.

Numerous experiments were now made for the purpose of ascertaining how large a quantity of arsenious acid might be contained in flesh without rendering it unfit food for these larvæ; without much success it must be confessed owing to the facility with which animal tissue is hardened by arsenious acid. If bits of flesh are soaked in an aqueous solution of this substance—no matter how dilute the solution may be—the arsenious acid will unite with the exterior portions of the flesh, forming a compound which, when exposed to the air, dries up in a few hours to the hardness of leather and forms an impervious coating. This hardening may indeed be somewhat delayed by wrapping the flesh in moist cloths, in which case the eggs of flies will often be deposited. These eggs produce living worms, unless so much arsenic has been used that the surface of the flesh is covered with a strong solution of it; but these worms never attained maturity in any of my experiments: they perished for the most part on account of the gradual hardening of the flesh which could not be entirely prevented, or from long continued contact with the solution of arsenious acid, a thin film of which was in some instances allowed to cover the surface of the flesh. In this case the grubs, an hour or two after leaving the egg, would commence crawling about very rapidly, evidently much irritated by the solution with which they were surrounded; this motion would be kept up sometimes during six or eight hours before death ensued.

We all know how quickly flies themselves are destroyed by arsenic—it being the active ingredient of nearly all the popular fly-papers, powders and poisons of the shops—it is a matter of no surprise therefore that the parents of the grubs in question

should have perished by scores, as they did while depositing their eggs upon the poisoned flesh. I may here observe that the only reference to this subject which I have been able to find is the remark of Jaeger (quoted by Orfila, *Traitè de Toxicologie*, Paris, 1852, I, 379) that "insects, such as spiders, flies, &c., quickly die when arsenious acid in solution is introduced into their digestive organs or applied to their soft exterior parts. *The larvæ of flies live a little longer than the insects which have undergone metamorphosis.*"

It being impossible to obtain satisfactory results by the method of experimenting which has just been described, I had commenced another series of experiments upon small animals, into the arterial systems of which solutions of arsenic of different degrees of concentration had been injected soon after death. These trials were brought to an abrupt termination by cold weather and the consequent disappearance of all flies. The same difficulties were however experienced here as in the previous cases though in a lesser degree; the flesh having always a tendency to become dry and hard. As this hardening did not take place so rapidly in the injected specimens as where bits of flesh had been soaked in a solution of arsenious acid, so the larvæ were enabled to attain a much larger size, before drying up, than in the previous instances. Indeed in several cases where favorable, moist positions had been secured, they lived for three or four days, becoming quite large and evidently almost ready to pass into the chrysalid state. This, upon the body of a rat weighing seven and a half ounces, into which four and a half grains of arsenious acid in aqueous solution had been injected.

In order to avoid the hardening influence of arsenious acid, solutions of arsenic acid—an eminently hygroscopic substance—were resorted to, but from having been used in too concentrated a state, the larvæ were destroyed, in the course of a few hours after birth, from contact with the solution which had oozed out upon the surface of the flesh; showing clearly, as with arsenious acid, that there is a limit to the amount of arsenic which these larvæ can support.

It is probable indeed that in every case the harmlessness of the poison depends entirely on its being so much diluted that it is no longer present in sufficient dose to destroy the larvæ. I am however inclined to believe that it will be found that they can consume with impunity any flesh into which arsenic has been carried by vital processes. A view which is certainly strongly supported by the fact of finding them upon the arsenicated human liver, an organ which, as is well known, is susceptible of absorbing a particularly large quantity of this poison.

On mentioning these results, some time since, to Prof. Jeffries Wyman, he recalled an instance, similar to those which have been mentioned, that had occurred a short time before in his own dissecting room. The arm of a subject which had been thoroughly injected with a solution of arsenic acid, having been inadvertently thrown aside and left unnoticed for several days was found completely riddled and alive with maggots.

This matter is one of some importance to chemists occupied with judicial investigations, who must not infer that a fly-blown organ can contain no arsenic; and is especially interesting from the fact that several authors have urged that the attention of experts should be particularly directed to the behavior of flies which may alight on any matter suspected of containing poison; if they die almost immediately arsenic is probably present and must be specially sought for. One case at least is on record (vid. Galtier, *Traité de Toxicologie*, Paris, 1855, I, 406) where the experts having searched in vain for laudanum which was supposed to have produced death, were led to look for arsenic, which they found, from having observed that the flies which fed upon the suspected organs soon perished.

But the subject is also, as it seems to me, worthy the attention of this society, as affording another indication of the great differences which exist between animals in their several conditions of metamorphosis* and of the caution with which all experiments upon the action of remedies or poisons on animals of any one species should be received when brought forward as indications of what that action will be upon other animals.

* I cannot refrain, moreover, from calling attention to its obvious bearing upon the important practical question of the destruction of insects injurious to vegetation, &c.; for it is highly probable that the larvæ of many other insects besides flies are less susceptible to the action of poisons than the perfect insect. Camphor, for example, is esteemed a preventive of the common clothes-moth, and its vapor is doubtless unpleasant to, if not absolutely destructive of, that insect when in its butterfly state; but, as is well known, while it remains a worm it can feed with impunity upon woolen stuffs, no matter how thickly they may be strewn with camphor. In like manner the larvæ of *Dermestes* and *Anthreni*, as proved by the experiments of Dr. Cabot (Proc. Bost. Soc. of Nat. Hist., vii, 5), can consume bird-skins which have been soaked in strong solutions of corrosive sublimate or in a saturated hot solution of arsenious acid, although they will not touch specimens which have been dipped in an alcoholic solution of strychnine.

ART. XIX.—*On some Reactions of the Salts of Lime and Magnesia, and on the Formation of Gypsums and Magnesian Rocks;* by T. STERRY HUNT, F.R.S., of the Geol. Survey of Canada.*

THE importance, in a geological point of view, of gypsum and of the carbonates of lime and magnesia in the forms of limestone, dolomite and magnesite, has led me to make a series of researches, whose results serve to explain many things hitherto obscure in the history of these substances. I propose in the present paper to describe, in the first place, certain chemical reactions of the salts of lime and magnesia; and, secondly, to consider the principal facts in the history of gypsums, and magnesian rocks, and the theory of their formation.

I.

On the action of solutions of bicarbonate of soda on salts of lime and magnesia.

1. In studying some years since the geological relations of alkaline mineral waters I found that by the action of a solution of carbonate of soda, a partial separation of the salts of lime from magnesia could be effected. Subsequent experiments, made with dilute solutions of bicarbonate of soda, have led me to the following results.

If to a solution containing besides common salt the chlorids of calcium and magnesium in the proportion of one equivalent of each, we add a solution of bicarbonate of soda in water saturated with carbonic acid, there separates a gelatinous precipitate, which very soon becomes crystalline. Collected and washed after a few hours, it is found to consist of carbonate of lime with but a small proportion of carbonate of magnesia, which in three successive precipitations from the same saline liquid, was found to equal 2·20, 2·00, and 1·23 per cent. The proportion of separated carbonate of magnesia diminished as the magnesian salts predominated in the solution, which now gave no further precipitate with bicarbonate of soda, but yielded by evaporation to dryness, a granular residue of hydrated carbonate of magnesia, with very little lime. In this way, a litre of the solution gave 4·19 grams of carbonate of magnesia, (MgO, CO_2) and only 0·14 grm. of carbonate of lime, while the soluble portion still retained in the form of chlorid, 1·176 grms. of magnesia, but no lime.

* The experiments detailed in the first section of this paper, as well as some in the second, have appeared in the Report of the Geol. Survey of Canada for 1857; the others of this section, together with those of the third, are from the forthcoming Report for 1858. See also this Journal, [2] xxvi, 110, and the Canadian Journal for May, 1859, p. 184. Many of the original observations in the fourth section already been published in the Reports of the Survey, but are now for the first time brought together.

2. A portion of the saline solution from which about one-third of the lime had been separated as above by bicarbonate of soda, gave by thirty minutes ebullition, a precipitate which for a litre equalled 0·666 grm. of carbonate of lime and 0·173 of carbonate of magnesia. Another portion of the same solution when evaporated to dryness at 120° F., gave 0·805 of carbonate of lime, but no magnesia.

3. If in the preceding experiments we employ a somewhat dilute solution of bicarbonate of soda there is no immediate precipitation of carbonate of lime. A solution was prepared with one litre of water, 29·2 grms. of sea-salt, 13·8 of chlorid of calcium, 50·7 of hydrated chlorid of magnesium, and 10·0 grms. of hydrated sulphate of soda, the three chlorids being in the proportion of two equivalents of the first and third to one of chlorid of calcium. In another litre of water were dissolved 42·0 grms. (equal to two equivalents) of bicarbonate of soda, and the liquid was then saturated with carbonic acid gas. Of this solution, 500 cubic centimeters would have been required to decompose the whole of the chlorid of calcium in the first, and 200 c. c. of it were gradually added to this with stirring, but without producing any visible effect. A further portion of 100 c. c. caused a slight turbidness, which was soon replaced by a crystalline precipitate, adhering to the sides of the vessel, and gradually increasing in amount. After a repose of forty hours at 68° F., the precipitate was collected and analyzed. It weighed 4·3 grms., and was carbonate of lime, with 3·3 p. c. of carbonate of magnesia.

4. The saline liquid, augmented by the washings of the precipitate, now measured 1·400 c. c.; of this one-half was mingled with 100 c. c. of the alkaline solution, being the quantity required for the decomposition of the remaining lime salt. No immediate change was apparent, but at the end of twenty-four hours there had separated a crystalline precipitate, weighing 2·288 grms., and consisting of carbonate of lime with only 2·6 p. c. of carbonate of magnesia.

5. The reason of this separation of lime from magnesia in the above experiments is evident, when we consider that carbonate of magnesia at ordinary temperatures decomposes the soluble salts of lime. Thus, according to Mitscherlich, magnesite or dolomite slowly transforms a solution of gypsum into one of sulphate of magnesia, carbonate of lime being formed at the same time. I have observed a similar reaction between dolomite and a solution of chlorid of calcium, especially at about 125° F. De Senarmont, and after him Bineau, found that solutions of bicarbonate of magnesia decompose chlorid of calcium in the cold, or at temperatures below 212° F. with precipitation of nearly pure carbonate of line, although the assertion of the latter, that sulphate of lime is decomposed by the same agent, is, as I shall

presently show, not quite correct. The power of decomposing gypsum appears to belong only to solutions containing monocarbonate of magnesia.

6. When a portion of moist recently precipitated hydrocarbonate of magnesia is added to a solution of bicarbonate of lime, it is immediately dissolved, but the transparent solution soon becomes turbid from separation of carbonate of lime. A similar reaction is produced by carbonate of soda, which precipitates carbonate of lime from a solution of the bicarbonate.

7. The preceding experiments show a remarkable degree of solubility in recently formed bicarbonate of lime; the liquid in § 4 deposited spontaneously an amount of carbonate of lime equal to 2·6 grms. per litre; and if we add, as in § 2, 0·8 grms. for the amount of carbonate remaining in solution, we shall have 3·4 grms. of carbonate of lime held for a time dissolved as bicarbonate in a litre of saline water, at the ordinary pressure of the atmosphere; the experiment detailed in § 3, indicates a solubility at least as great.

Boutron and Boudet, by treating lime-water with carbonic acid, obtained supersaturated solutions holding 2·3 grms. of carbonate in a litre, but the half of this was soon deposited, and they found that a litre of water charged with carbonic acid, under a pressure of several atmospheres, cannot retain more than 1·16 grms. of carbonate of lime in permanent solution. We have seen in § 2, that a saline solution retains after some hours exposure, 0·805 grms. of carbonate. In other trials I have found 0·838 and 0·915 grms. of carbonate of lime in pure water saturated with carbonic acid at the atmospheric pressure. A solution prepared under a pressure of several atmospheres with excess of carbonic acid, and then exposed for twelve hours in a loosely covered vessel, still retained 0·730 grms. of carbonate of lime in a litre. Bischof estimates the solubility of bicarbonate of lime at one part in 1000, which may be regarded as correct.

Lassaigne found a saturated solution of bicarbonate of lime to contain six equivalents of carbonic acid for one of lime; but from an experiment of Bischof it would appear, that an amount of lime equal to 0·59 grms. of carbonate to a litre may exist in solution as sesqui-carbonate.—(*Lehrbuch der Geologie*, ii, 1126.)

8. According to the same author, when a current of carbonic acid is passed for a long time through water containing pure magnesia in suspensson, there is dissolved a quantity equal to 1·35 grms. of carbonate of magnesia to a litre.—(*Ibid.*, i, 387.) Under certain conditions, however, water is capable of dissolving an amount of carbonate of magnesia many times greater than that stated by Bischof. In § 1 we have seen that a litre of water, containing at the same time chlorids of sodium and magnesium, may hold dissolved as bicarbonate 4·19 grms. of carbonate of mag-

nesia; and by adding known quantities of carbonate of soda to a solution of chlorid of magnesium and passing a current of carbonic acid through the mixture, I have found it easy to obtain permanent solutions, containing not less than 21·0 grms. of monocarbonate of magnesia in a litre. Bineau, by prolonging for several days the action of carbonic acid, obtained a solution which contained in a litre 11·2 grms. of magnesia (equal to 23·5 grs. of magnesian carbonate), combined with very nearly two equivalents of carbonic acid.

The observations of H. Rose, and of Longchamp, show that the presence of alkaline chlorids, sulphates or carbonates, as well as of magnesian salts, increases the solubility of carbonate of magnesia in water. This may explain the great difference between the determination of Bischof, in which all foreign salts were excluded from the solution, and the experiments of Bineau and myself, with solutions which always contained salts of soda or magnesia. That the presence of such salts does not, on the contrary, augment the solubility of bicarbonate of lime, is apparent from § 2.

9. Bineau found that during the spontaneous evaporation of a solution of bicarbonate of magnesia carbonic acid escaped, and carbonate of magnesia separated, until at length the liquid retained in a litre only from 0·10 to 0·17 grms. of carbonate of magnesia, with sufficient carbonic acid to form a sesquicarbonate. Such solutions, when transferred to closed vessels, were spontaneously decomposed, hydrated carbonate of magnesia separating while a bicarbonate remained in solution.—(*Ann. de Chim. et de Phys.*, [3], li, 302.)

This spontaneous decomposition of the sesquicarbonate of magnesia into monocarbonate and bicarbonate is somewhat analogous to that exhibited by a recent supersaturated solution of bicarbonate of lime, which as we have seen, breaks up into an insoluble monocarbonate and free carbonic acid or a very acid salt. The reaction is observed in a remarkable manner during the evaporation of certain saline mineral waters, which contain abundance of bicarbonate of magnesia. A portion of water from the Plantagenet spring was left to evaporate in an open basin in summer, until its volume was reduced to one-fifth. The clear solution was then decanted from a crystalline crust of carbonates of lime and magnesia, and transferred to a carefully closed flask, where after two or three days, it deposited a strongly adherent crust of hydrated carbonate of magnesia, chiefly on the lower parts of the vessel. The amount of this deposit was equal to 0·772 grms. of carbonate of magnesia to a litre of the concentrated liquid, which contained no lime, but abundance of bicarbonate and chlorid of magnesium, after the separation of the precipitate.

II.

On the reaction between solutions of bicarbonate of lime and the sulphates of soda and magnesia.

10. If to a solution of bicarbonate of lime we add a portion of sulphate of soda or sulphate of magnesia, there are formed by double decomposition, bicarbonate of soda or bicarbonate of magnesia and sulphate of lime, which latter salt may be precipitated by the addition of alcohol.

To 400 cubic centimeters of a recently prepared transparent solution of bicarbonate of lime there were added two grams of hydrated sulphate of soda, and the solution was then mingled with an equal volume of alcohol of 90 p. c. A white flocculent precipitate immediately appeared, which was collected after a few hours, and washed with dilute alcohol. It was completely soluble in water, but was again thrown down by alcohol, with the addition of a few drops of hydrochloric acid, and was pure sulphate of lime, weighing, when ignited, 0·428 grms., which corresponds to 0·915 grms. of carbonate of lime to the litre.

11. 400 c. c. of the same solution of bicarbonate of lime were treated with 2·0 grms. of crystallized sulphate of magnesia and alcohol, as above; the precipitated sulphate of lime equalled 0·467 grm. The filtrate from which the alcohol had been expelled gave by boiling, a copious precipitate containing a little lime and 0·276 grms. of carbonate of magnesia; theory requires 0·288.

12. 500 c. c. of a recent solution of bicarbonate of lime with 2·0 grms. of hydrated sulphate of soda and an equal volume of alcohol, gave a precipitate of gypsum, which when dissolved in water and reprecipitated as in § 10, gave 0·570 of sulphate of lime, equal to ·838 grm. of carbonate of lime to a litre. The alkaline filtrate was evaporated to dryness, the residue redissolved, and precipitated at a boiling heat by a dilute solution of chlorid of calcium. The carbonate of lime thus obtained was free from sulphate, and corresponded to ·445 grm. of carbonate of soda; theory demands ·442.

13. In consequence of this formation of gypsum, the solubility of carbonate of lime in carbonic acid water is, as I have found, very much increased by the presence of sulphate of soda, or sulphate of magnesia. To a little more than 200 c. c. of lime-water were added 4·0 grms. of sulphate of soda, and a stream of carefully washed carbonic acid gas was then passed through the liquid for four hours, at the end of which time the solution of the carbonate of lime was nearly complete. On the addition of an equal volume of absolute alcohol, there fell a precipitate of gypsum, which, when washed, effervesced slightly with hydrochloric acid from a trace of carbonate of lime; but being again thrown down from its aqueous solution by alcohol, gave 0·555 grms. of ignited

sulphate of lime, equal to about 2·0 grms. of carbonate of lime to a litre. The carbonate of soda in the alkaline filtrate was found, by the indirect method of § 12, equal to ·434 grm.; theory requires ·432.

14. In another experiment, a dilute solution of sulphate of soda was treated with an excess of bicarbonate of lime, in order to determine whether it were possible to decompose completely the soda-salt by this means. After throwing down the gypsum by alcohol, the residue contained for a litre 1·080 of carbonate and 0·520 of sulphate of soda.

15. 250 c. c. of water, containing ten grams of hydrated sulphate of soda, and two grams of pure carbonate of lime, were exposed for an hour and a half to a current of carbonic acid gas, and the solution was then left for four hours in a covered flask, after which 150 c. c. of the clear liquid were mixed with an equal volume of absolute alcohol. A copious precipitate was formed, which, after twelve hours, was collected; it was completely soluble in 200 c. c. of water, from which alcohol threw down ·343 grms. of sulphate of lime, besides a farther portion of ·020 grs. from the evaporated filtrate, making a total of 363 grs., equal to 2·420 grs. of sulphate of lime to the litre.

16. 200 c. c. of a similar solution to the last, gave with alcohol, a precipitate of gypsum, which was readily soluble in water, and being thrown down as oxalate, gave an amount of carbonate of lime equal to 1·820 grms. to the litre, or 2·475 of sulphate of lime.

17. A current of carbonic acid gas was passed for an hour and a quarter through a solution containing sulphate of magnesia and carbonate of lime. The filtered liquid remained transparent after many hours exposure to the air; but 200 c. c. of it gave with alcohol a precipitate of gypsum, which was collected after twelve hours and was completely soluble in water, from which solution the lime was thrown down as oxalate, giving an amount of carbonate equal to 1·565 grms. or to 2·128 grms. of sulphate of lime to the litre. The alcoholic filtrate by evaporation to dryness over a water-bath, gave a little carbonate of lime, and an amount of carbonate of magnesia equal to 1·100 grms. to the litre; theory requires 1·312, but it is difficult to separate in this way the whole of the carbonate of magnesia from an excess of sulphate.

18. It thus appears that in the presence of sulphate of soda or magnesia, water saturated with carbonic acid is capable of dissolving nearly twice the ordinary proportion of carbonate of lime, or from 1·565 to 1·820 grms. to the litre. The lime in these liquids is doubtless to be regarded as existing chiefly as sulphate, of which salt they are nearly saturated solutions. The determinations, in § 15, § 16 and § 17, give respectively one

part of sulphate of lime for 413, 404 and 459 parts of water. The solubility of this salt in pure water has been variously stated. According to Bucholz, one part of sulphate of lime requires 460 parts of hot or cold water for its solution; but Giese gives 380 parts of cold, and 388 of boiling water, its solubility being increased, according to O. Henry, by the presence of sulphate of soda.—(Gmelin, *Handbook*, (Cavendish ed.,) iii, 202.)

I determined the amount of sulphate of lime in a solution prepared by agitating frequently for several days, pure artificially prepared gypsum, with distilled water, at 60° F. The lime was thrown down as oxalate, and indicated one part of sulphate of lime to 483 parts of water. Another portion of the same solution was evaporated at a gentle heat until crystals of gypsum separated, and the clear saturated solution decanted from these crystals after twelve hours of repose at 60° F., contained one part of sulphate of lime for 372 parts of water, which approaches closely to the determination of Giese.

19. In a late paper, by Bineau, on the earthy carbonates already cited (*Ann. de Chim. et de Phys.*, [3] li., 297), the author refers to a memoir of Mr. E. Marchand, who asserts that a litre of water may hold dissolved as bicarbonate, about 2·5 grms. of carbonate of lime, and that sulphate of lime and alkaline bicarbonates may co-exist in natural waters. These statements are controverted by Bineau, but the latter of them is fully sustained by the experiments which we have described, while the augmented solubility of the carbonate of lime is to a great extent explained if the solutions of Marchand contained soluble sulphates. I have not however been able to verify the assertion of Marchand, that sulphate of lime separates from mixed solutions of bicarbonate of lime and sulphate of soda, unless indeed by the intervention of alcohol; although as will now be shown gypsum may be crystallized from mingled aqueous solutions of bicarbonate of lime and sulphate of magnesia.

20. When a solution like that of § 17 is evaporated at a gentle heat, it might be expected that carbonate of lime, being a less soluble salt than gypsum, or the carbonate of magnesia, would be deposited. I have found, however, that from such a solution under these conditions, gypsum separates, while bicarbonate of magnesia remains in solution. The sulphate of magnesia employed in the following experiments was carefully recrystallized and contained no traces of lime or free acid; its solution did not alter the color of curcuma, but slowly restored that of reddened litmus. The carbonic acid employed was evolved from limestone hydrochloric acid, and carefully washed, so that its solution was not troubled by nitrate of silver.

To 500 c. c. of water were added twelve grams of sulphate of magnesia and half a gram of precipitated carbonate of lime, and

a current of carbonic acid gas passed for two hours through the liquid, when the carbonate of lime was nearly all dissolved. The solution was now evaporated in a porcelain basin at a temperature varying from 90° to 110° F., until crystals of sulphate of magnesia separated; a little water was then added and the solution, being immediately filtered, contained no lime-salt, but was strongly alkaline to curcuma paper. When heated it became turbid before boiling, and after fifteen minutes ebullition deposited a flocculent precipitate containing ·208 grm. of carbonate of magnesia. The basin in which the evaporation had been conducted was covered with a crystalline crust which effervesced but slightly with hydrochloric acid; it was soluble in a large volume of water, and was principally gypsum.

21. To 800 c.c. of water were added twenty grams of sulphate of magnesia and one gram of pure carbonate of lime; a current of gas was now passed through the liquid for an hour and a half, when the lime was nearly all dissolved; the solution was saturated with the gas, but contained no trace of chlorine. It was neutral to curcuma, and gave with alcohol a precipitate of gypsum. A portion of it heated to boiling remained clear for five minutes, but then grew turbid and deposited an abundant precipitate of carbonate of lime.

200 c. c. of this solution were evaporated at a temperature of 180°–190° F., until crystals of sulphate of magnesia separated; after twelve hours repose in the cold a little water was added and the solution decanted from a precipitate, of which ·272 grm. were collected; when this was treated with hydrochloric acid and dilute alcohol a portion of carbonate of lime was removed and there remained ·236 grm. of crystalline gypsum, weighing when ignited, ·185, equal to ·925 grm. of sulphate of lime to the litre. The filtered solution of sulphate of magnesia was strongly alkaline to curcuma, and gave by boiling, a precipitate which contained no lime but a portion of carbonate of magnesia equal to ·490 grm. to the litre; theory demands ·570.

22. A solution of twelve grams of sulphate of magnesia in 300 c. c. of water was mingled with carbonate of lime and saturated with carbonic acid. It was then filtered and evaporated at about 160° F., until sulphate of magnesia separated. By this means a sparingly soluble crystalline precipitate was formed, which contained gypsum equal to ·235 grm. of sulphate of lime, with a little carbonate. The filtrate gave by boiling a precipitate of carbonate of magnesia which equalled ·098, while theory demands ·145.

To 600 c. c. of a solution of bicarbonate of lime were added twenty grams of sulphate of magnesia, when the liquid which was before turbid from a portion of suspended carbonate, became clear, and gave by evaporation at 90° F. a precipitate contain-

ing ·154 of sulphate of lime, with some carbonate of lime and a trace only of magnesia.

A solution of five grams of sulphate of magnesia was mingled with a portion of solution of bicarbonate of lime, and evaporated at 160°–180° F., further portions of the latter, amounting in all to 300 c. c. being added as the evaporation went on. There was deposited a mixture of carbonate of lime, with crystalline gypsum equal to ·373 grm. of sulphate of lime to the litre.

23. It will be remarked, that while the recent solution containing gypsum and carbonate of magnesia with excess of carbonic acid is neutral to curcuma and may be boiled for some minutes before a precipitate of carbonate appears, the liquid from which gypsum has been deposited by evaporation is strongly alkaline to curcuma paper, and lets fall a precipitate of carbonate of magnesia, even before attaining the boiling point; this precipitate is in part redissolved as the liquid cools. When this alkaline liquid is mixed with a solution of gypsum, it deposits in a few hours, especially if gently warmed, a crystalline precipitate of carbonate of lime, resulting from the decomposition of the sulphate of lime by the carbonate of magnesia.

The sulphate of magnesia retains the carbonate of magnesia in solution in such a manner that the latter is not rendered completely insoluble, even when the liquid is evaporated to dryness over a water-bath. Hence the deficiency observed in the determinations of carbonate of magnesia in § 17, § 21 and § 22, where a large proportion of sulphate was present. The filtrate from the carbonate in these cases is still alkaline, and gives with nitrates of silver and copper, precipitates of carbonates.

24. In the preceding experiments all salts, other than those concerned in the reaction, were excluded, but similar results are obtained in the presence of sea-salt and chlorid of magnesium. Twenty grams of pure chlorid of sodium, and ten grams of sulphate of magnesia, with a portion of carbonate of lime, were added to 800 c. c. of water, and the solution saturated with carbonic acid gas. Of this liquid 400 c. c. were evaporated at 160°–180° F., until sea-salt separated, and gave ·045 grm. of sulphate of lime, mixed with ·291 of carbonate.

Ten grams of chlorid of sodium, and twenty grams of crystallized chlorid of magnesium were added to 600 c. c. of solution of bicarbonate of lime, containing two grams of sulphate of magnesia; 300 c. c. of this solution were now evaporated at 160°–180° F., until crystals of sea-salt appeared; there were obtained ·057 grm. of sulphate of lime.

25. A saturated solution of one part of sea-salt and two parts of sulphate of magnesia was exposed to a cold of 32° F., when a large amount of sulphate of soda separated. The mother liquor, containing besides some sea-salt and sulphate of magnesia, a

large amount of chlorid of magnesium, was diluted with four parts of water. 500 c. c. of this solution were mingled with carbonate of lime, saturated with carbonic acid, and then evaporated at a temperature of 85°–90° F., to one-twelfth, when crystals of sea-salt separated, and a crystalline residue of gypsum was obtained. It did not effervesce with hydrochloric acid, and was soluble in a large volume of water. The saline liquid by evaporation to dryness, gave ·331 of carbonate of magnesia.

To another portion of 100 c. c. of the saline solution employed in the last experiment, 500 c. c. of a solution of bicarbonate of lime were gradually added, the mixture being meanwhile evaporated at a temperature below 100° F., and at length carried to dryness. On treating the mass with water, the strongly saline filtrate was found to contain no lime-salt, but sulphate of lime was abundant in the washings, and the residue on the filter, when treated with hydrochloric acid, left crystalline grains of gypsum.

26. In the foregoing experiments it is not easy to separate the more soluble salts from the gypsum, which, although insoluble in saturated saline liquids, is readily dissolved by washing with water, in place of which a solution of gypsum may be used. In either case, as a solution of sulphate of lime is decomposed by the dissolved carbonate of magnesia, the washings should not be mingled with the alkaline filtrate in which we wish to determine this salt. As a solution of magnesian carbonate which has lost its excess of carbonic acid by evaporation is incompatible with dissolved gypsum, it is evident that the presence of an excess of this acid must be one of the conditions required for the crystallization of gypsum from such a solution. It often happens that some slight variations in the conditions of the experiment with two portions of the same solution, will give in one case abundance of gypsum and in the other chiefly carbonate of lime.

27. The power of bicarbonate of baryta to decompose sulphate of magnesia and even sulphate of soda with precipitation of sulphate of baryta is well known; and I have found that the insolubility of the sulphate of strontia determines a similar result. A solution of bicarbonate of strontia, prepared by passing carbonic acid gas through water holding the carbonate in suspension, was divided into two portions, one of which was mingled with a portion of sulphate of soda and the other with sulphate of magnesia. The mixtures, at first clear, soon became troubled from the separation of a precipitate, which adhered to the sides of the vessels, and like ammonio-magnesian phosphate, along the lines marked by the rod in stirring. After twelve hours the liquids decanted from the precipitate, which was in each case, sulphate of strontia, were evaporated at a gentle heat to a small volume, during which process they deposited a portion of car-

bonate of strontia. The first contained some sulphate, with a large proportion of carbonate of soda, and the second, which gave no trace of dissolved strontia, let fall by boiling a copious precipitate of magnesian carbonate.

An analogous reaction between the sulphates of iron and zinc and bicarbonate of lime, resulting in the production of gypsum and carbonates of zinc and iron, has already been suggested by Monheim to explain the association of these minerals in a modern deposit from the waters of a mine. The experiments of Bischof have established the fact of such a decomposition for the sulphate of copper, as well as for the sulphates of zinc, and protoxyd of iron.—(*Lehrbuch*, ii, 1198–1202.)

III.

On the formation of the double carbonate of lime and magnesia.

28. The carbonates of lime and magnesia, although so frequently combined in nature in the form of dolomite, exhibit, under ordinary circumstances, little disposition to unite with each other. The carbonate of lime, as we have seen, separates nearly pure, from solutions of bicarbonate of magnesia, at ordinary temperatures; and if by the aid of heat a portion of magnesian carbonate is at the same time precipitated, the two appear to be only in a state of admixture.

Karsten long since observed that dilute acetic acid, at temperatures below 32° F., readily dissolves carbonate of lime, but is without action on the double carbonate of lime and magnesia, which constitutes dolomite. By this means he was enabled to make a proximate analysis of many magnesian limestones, which he found to be mixtures of dolomite with carbonate of lime. Before undertaking a series of experiments on the production of this double carbonate, I endeavored to fix by experiment the limits of error in Karsten's process.

29. For this purpose I took a pure acetic acid, containing 29·4 p. c. of glacial acid; this was mixed with an equal volume of water, so that the dilute acid used in the following experiments contained about 15 p. c. of glacial acetic acid. Unless otherwise specified, it was employed at 32° F. (lower temperatures being difficult to regulate), and this temperature was maintained by a bath of ice and water. In these conditions the acid dissolved precipitated carbonate of lime and pulverized limestone with lively effervescence, even when farther diluted. A pure crystalline dolomite in fine powder was however slowly attacked, subsiding to the bottom of the liquid, and disengaging small bubbles of gas from time to time. After six hours digestion, with a large excess of the acid at 32° F., 1·68 grs. of this dolomite had lost ·082 of carbonate of lime, and ·063 of carbonate

of magnesia, equal to 8·63 p. c. of dolomite, (containing 43·5 p. c. of magnesian carbonate). At a temperature of 60° F., the same acid caused a slow but continued disengagement of gas bubbles from the powdered dolomite, which after 30 hours lost 28·0 p. c. of its weight, the dissolved portion containing 45·0 p. c. of carbonate of magnesia. At 125° F. the action of the acid upon the powdered dolomite was accompanied with gentle effervescence, and the amount dissolved after two hours digestion, was 13·6 per cent.

A white crystalline magnesite from Styria, whose only impurity was a portion of carbonate of iron equal to 0·9 p. c. of peroxyd, and which was slowly but completely soluble in hot hydrochloric acid, was also slightly attacked by dilute acetic acid at 60° F.; after twelve hours digestion there were dissolved 0·63 p. c. of the carbonate. At 125° F. however a distinct effervescence was produced with the acid, and at the end of three hours 11·0 p. c. of the magnesite were dissolved.

From these experiments it was evident that although not insoluble in acetic acid of 15·0 p. c. at 32° F., this liquid might serve to separate dolomite from carbonate of lime, and also at a higher temperature to effect a partial separation of dolomite from magnesite.

30. The insolubility of the double carbonate of lime and magnesia in carbonic acid water is also an important fact in the history of dolomite. Bischof found that by the prolonged action of a solution of carbonic acid upon a limestone containing 11·54 p. c. of magnesian carbonate, there were dissolved 4·29 p. c. of carbonate of lime and not a trace of magnesia. In like manner a manganesian iron-spar, which contained 14·0 p. c. of carbonate of lime and 15·0 p. c. of carbonate of magnesia, gave to carbonic acid water four parts of carbonate of lime for one part of magnesian carbonate.—(*Lehrbuch*, ii, 1176.)

31. Accepting the idea that dolomites have been formed by the alteration of beds of carbonate of lime, Haidinger long since suggested that a solution of sulphate of magnesia at a high temperature might produce this change, giving rise by double decomposition to carbonate of magnesia and sulphate of lime, although Mitscherlich had shown that at ordinary temperatures sulphate of lime and carbonate of magnesia are mutually decomposed (§ 5). Von Morlot subsequently verified this conjecture of Haidinger; he found that by heating together to 200° centigrade, for six hours in a sealed tube a mixture of two equivalents of carbonate of lime and one equivalent of crystallized sulphate of magnesia, the latter was completely decomposed, with the production of sulphate of lime and carbonate of magnesia, which he seems to have regarded as forming with the excess of carbonate of lime a double carbonate.—(Liebig and Kopp,

Jahresbericht, 1848, ii, 500). Desirous of verifying this observation I have repeated the experiment of von Morlot, but have found that although the sulphate of magnesia is indeed completely converted into carbonate, this remains for the most part in the form of magnesite mechanically intermixed with the excess of carbonate of lime, which may be separated by the aid of dilute acetic acid.

32. 100 parts of pure precipitated carbonate of lime (two equivalents) and 123 parts of crystalized sulphate of magnesia (one equivalent) were intimately mingled and exposed in sealed glass tubes for six hours to a temperature of 392° F. (200° C.) The resulting white tasteless mass was treated with cold dilute acetic acid which immediately caused a strong effervescence. When this action had subsided the residue was washed with cold water and then treated with dilute hydrochloric acid which produced no effect in the cold, but by the aid of a gentle heat dissolved a large portion with effervescence. The addition of alcohol threw down abundance of gypsum from the solution, and the filtrate from this being evaporated to dryness and then moistened with hydrochloric acid, was digested with absolute alcohol, by which the chlorids alone were dissolved, leaving a small residue of gypsum, and were found to consist of chlorid of magnesium with but very little chlorid of calcium. The acetic acid on the contrary had dissolved a large portion of carbonate of lime with but little carbonate of magnesia and a little gypsum. Thus in one experiment the acetic solution gave besides ·079 of sulphate, ·523 of carbonate of lime and ·016 of carbonate of magnesia, equal to 3·0 p. c. of the dissolved carbonates, while the portion insoluble in acetic acid, separated from gypsum by the process just described, gave ·459 of carbonate of magnesia and ·017 of carbonate of lime, or 96·3 p. c. of magnesian carbonate. In another experiment there was obtained from the residue insoluble in acetic acid, carbonate of magnesia ·437, carbonate of lime ·020.

The crystallized sulphate of magnesia undergoes the aqueous fusion at about 230° F., and contains sufficient water to render the mixture with carbonate of lime somewhat moist after heating. The above experiment was however repeated with the addition of a portion of water, but with the same result as before; the carbonates not dissolved by acetic acid consisted of ·242 of carbonate of magnesia and ·008 of carbonate of lime.

33. The experiments of de Senarmont have shown that when carbonate of magnesia is formed at a temperature of 150°–175° C. by the reaction between solutions of sulphate of magnesia and carbonate of soda, or by the decomposition of a solution of bicarbonate of magnesia, it separates as a crystalline powder sparingly soluble in acids and apparently identical with magnesite. —*Ann. de Chim. et de Phys.* [3], xxxii, 148. It is evident from

the results just detailed that a similar result takes place when carbonate of lime is substituted for the carbonate of soda, the carbonate of magnesia formed in the presence of an excess of carbonate of lime retaining only three or four per cent of this carbonate.

34. According to Marignac, when carbonate of lime is heated in sealed tubes with a solution of chlorid of magnesium to 200° C. for six hours, there is obtained, besides a portion of chlorid of calcium, a product consisting of 48·0 parts of carbonate of lime and 52·0 of carbonate of magnesia; at the end of two hours' heating, the proportion of magnesian carbonate was less. (*Bul. Soc. Geol. de France* [2] vi, 318.) It does not appear whether Marignac examined the product by the aid of acetic acid, but I find that in this process a double carbonate of lime and magnesia is really formed.

A mixture of six parts of pure precipitated carbonate of lime with five parts of pure crystallized hydrated chlorid of magnesium, dissolved in a little water, was placed in sealed tubes and heated for eight hours to a temperature of 150° C. which was gradually raised to 220° C. Two hours after cooling, the matter was removed from the tubes, washed, dried, and treated with dilute acetic acid, which caused a violent effervescence; as soon as this had subsided, the filtrate, which contained a large excess of acid and still attacked carbonate of lime with energy, was separated by filtration from the undissolved residue which was but little more than one-fifth of the whole. The dissolved portion consisted in 100 parts of carbonate of lime 96·86, carbonate of magnesia 3·14.

35. Previous experiments had shown me that in operating with glass tubes, a portion of silicate of magnesia is always formed,* and as this is decomposed by mineral acids, acetic acid was employed in the analysis of the undissolved carbonates, of which ·800 grm. from the last experiment were treated with acetic

* The glass of the tubes is always more or less attacked in these experiments, water alone at the temperature employed dissolving from it a portion of alkaline silicate, which by double decomposition with carbonate or chlorid gives rise to a silicate of magnesia. A mixture of carbonates of lime and magnesia with water and carbonate of soda having been heated for several hours in glass tubes to 150°–170° C. the greater part of the magnesia was found to be changed into a light flocculent hydrated silicate insoluble in acetic acid, but decomposed without effervescence by digestion with hydrochloric acid, which took up a large portion of magnesia with only a trace of lime, and left granular silica. I have not yet obtained this silicate in sufficient purity to determine its precise constitution.

When a mixture of magnesite and crystalline quartz was heated for several weeks in a copper vessel with a solution of carbonate of soda to 130° C. it was found that nearly the whole of the quartz had been converted into a hydrous silicate of magnesia, after decomposing which by sulphuric acid the now soluble silica could be taken up by a boiling solution of carbonate of soda. I reserve for another place the results of a series of researches upon the artificial formation of silicates by the reaction of silica upon carbonates, which as I have elsewhere shown plays a most important part in the chemical alteration of sedimentary rocks.—*Proc. Royal Society*, and this Journal, [2], xxiii, 437.

acid of 15 p. c. at 60° F. No action was apparent even after some minutes, but with a heat of 120° F. a gentle effervescence ensued. When this ceased there remained a flocculent residue equal to 15·7 p. c., and the undissolved portion gave carbonate of lime 37·6, carbonate of magnesia 62·4.

A portion of ·500 grm. of the same carbonates was now digested with dilute acetic acid at 60° F. for several hours. The soluble portion contained carbonate of lime 40·0, and carbonate of magnesia 60·0, while the undissolved residue equalled 22·4 p. c. It effervesced freely with warm somewhat dilute hydrochloric acid and left a silicious residue of ·032 grm., while the dissolved portion gave ·007 of carbonate of lime and ·060 of carbonate of magnesia.

36. In another experiment with carbonate of lime and chlorid of magnesium, the mixture of carbonates as extracted from the tubes contained 24·4 p. c. of magnesian carbonate. This was treated with acetic acid at 60° F., and the digestion continued for some length of time, the result of which was that a large portion of the double carbonate was taken up and the dissolved portion contained 11·4 p. c. of carbonate of magnesia, while the undissolved residue was carbonate of magnesia with but 30·3 p. c. of carbonate of lime, and in a third experiment under similar circumstances contained only 23·6 per cent. These experiments were made before I had determined the solubility of the double carbonate in acetic acid at the ordinary temperature.

It is evident from the above results that these magnesian carbonates, which retain after the action of acetic acid from 23·0 to 37·0 p. c. of carbonate of lime, are mixtures of a double carbonate of lime and magnesia with a less soluble carbonate of magnesian, from which the double salt may be partially separated by the prolonged action of acetic acid at ordinary temperatures, as shown in § 35.

37. In the experiments § 34 and § 36 it appears that the carbonate of magnesia unites, at the moment of its formation, with a portion of carbonate of lime to form the double carbonate. It remained to be seen whether mixtures of the two carbonates would combine directly, and experiments were made with the Styrian magnesite (§ 29) which was mingled in fine powder with carbonate of lime and heated for some hours in sealed tubes to 200° C. with a dilute solution of chlorid of calcium. No combination took place, and the carbonate of lime was afterwards completely removed from the magnesite by cold dilute acetic acid.

The dense insoluble magnesite, as might be conjectured from its occurrence in the products of the previous experiments, exhibits none of that aptitude to combine with carbonate of lime which seems to characterize the newly formed magnesian carbonate before passing into this sparingly soluble condition, a

change as we have seen in the experiments of de Senarmont (§ 33) takes place at from 155° to 175° C. The hydrated carbonates of magnesia formed at low temperatures and readily soluble in dilute acids, are in like manner, when heated under pressure, to prevent the loss of carbonic acid, converted into magnesite; if under these conditions carbonate of lime be present the two combine to form a double salt, possessing the chemical characters of dolomite.*

38. In his researches on the double carbonates, H. Deville has described an anhydrous crystalline salt composed of one equivalent each of the carbonates of magnesia and soda. This double carbonate is insoluble in cold water, but readily dissolves in acetic acid. When it is heated with a solution of chlorid of magnesium in sealed tubes to 200° C. chlorid of sodium and sparingly soluble magnesite are obtained. When warmed with a solution of chlorid of calcium this double carbonate is decomposed and gives rise to a mixture of carbonates of lime and magnesia readily soluble in acetic acid; at a higher temperature under pressure the two carbonates unite to form a double salt.

39. Three parts of the finely pulverized carbonate of magnesia and soda were added to two parts of chlorid of calcium dissolved in a little water and rendered slightly acid by hydrochloric acid. The mixture being placed in hermetically sealed glass tubes, these were heated for some hours in a bath of boiling water with frequent agitation, and then in an oil-bath for eight hours, the temperature being slowly raised from 130° to 220° C. On cooling, the saline liquid in the tubes was found to contain, besides chlorids of sodium and calcium, a considerable amount of chlorid of magnesium. A portion of the double salt became coated over by the precipitated carbonate of lime and thus protected from the further action of the chlorid of calcium.

The carbonates from the above experiment were treated with a large excess of dilute acetic acid at 60° F. till effervescence ceased. ·600 grm. of the residue were now digested for two hours with dilute acid at 60° F.; the action was accompanied with a slow and constant disengagement of carbonic acid gas, and the solution gave ·302 grm. of carbonates, of which the carbonate of lime constituted 41·3 p. c. The undissolved portion effervesced with

* I have shown, from a consideration of the densities of the rhombohedral carbon spars, that supposing them to possess a common atomic volume, we may represent calcite by $15(C_2M_2O_6)$ while dolomite and chalybite are $18(C_2M_2O_6)$ and magnesite and carbonate of zinc (smithsonite) $20(C_2M_2O_6)$. Farther examples of polymerism in mineral compounds are seen in sillimanite and cyanite, in meionite and zoisite (saussurite), and in hornblende and pyroxene. These latter, accepting the late analyses of Rammelsberg, may be represented respectively by $25(SiMO_3)$ and $28(SiMO_3)$, wollastonite being $22(SiMO_3)$; these formulas correspond to three types of homœomorphous isomeric silicates. (See this Journal, [2], xvi, 203, and *Comptes Rendus de l'Acad.* 1855, xli, 79.)

warm hydrochloric acid, which dissolved ·178 of carbonates containing only 12·3 p. c. of carbonate of lime, leaving ·116 grm. of insoluble silicious residue.

40. In a repetition of the above experiments the carbonates were treated with acetic acid at 32° F. till effervescence ceased, and a portion of the remaining double carbonate was digested for some time with acetic acid at 125° F. which took up 80·0 p. c. of carbonates containing 38·4 p. c. of carbonate of lime. The insoluble portion did not effervesce with hydrochloric acid, which however removed from it a portion of magnesia but no lime, and left a silicious residue. Another portion was digested for several hours with acetic acid at 60° F. which took up 78·0 p. c. of carbonates containing 40·8 of carbonate of lime. The insoluble residue effervesced freely with warm sulphuric acid, which dissolved a portion of magnesia but no trace of lime.

41. Other experiments were made in which carbonate of lime was mingled with solutions of sulphate of magnesia and carbonate of soda, so that carbonate of magnesia would be formed, the sulphate of magnesia being in slight excess in one case and the alkaline carbonate in another. In another experiment, a mixture of ter-hydrated carbonate of magnesia and carbonate of lime with water and carbonate of soda, was employed. All of these were heated in metallic tubes to from 130° to 200° C. and the products digested for a long time with acetic acid at 60° F. These experiments were made at a time when I had not determined the solubility of the double carbonate under such conditions, and the consequence was that the residues obtained were chiefly carbonate of magnesia, which was scarcely attacked by cold acids, but retained in the form of the double salt from six to eleven per cent of carbonate of lime. In another trial, however, a mixture of hydro-carbonate (*magnesia alba*) and carbonate of lime with water and an excess of bicarbonate of soda was exposed in the boiler of a steam engine to a temperature of from 120° to 130° C. for several hours every day during ten weeks. The washed residue was then digested with acetic acid only until effervescence ceased; after which it was completely soluble in hydrochloric acid, and gave carbonate of lime 46·3, carbonate of magnesia 53·7.

42. The preceding experiments show that carbonate of magnesia, whether (1) as magnesia alba in presence of excess of carbonic acid, from bicarbonate of soda, or (2) a ter-hydrated carbonate, or (3) as precipitated by bicarbonate of soda from sulphate of magnesia, or (4) by carbonate of lime from a solution of chlorid of magnesium at an elevated temperature, or (5) as separated from the double carbonate of magnesia and soda by a solution of chlorid of calcium, will in the presence of water unite directly with carbonate of lime to form a double carbonate of lime and

magnesia, sparingly soluble in cold dilute acetic acid. This combination takes place between 180° and 200° C., at which temperatures the magnesian carbonate tends to pass into the still less soluble state of magnesite, in which, as we have shown, it no longer shows any disposition to unite with carbonate of lime. Hence it happens that in all our experiments a portion of magnesite is mingled with the dolomite, and cannot be completely separated from it. Dilute acids slowly attack both, but unequally, so that we finally obtain a residue which contains carbonate of magnesia free from lime: but the solution having taken up a portion of magnesite, contains more magnesia than is required to form a dolomite with the carbonate of lime; so that we have from 53·0 to 60·0 p. c. of magnesian carbonate instead of 45·0 as in pure dolomite. In nature the combination of the two carbonates has doubtless taken place slowly, and necessarily at the lowest temperature, which is probably much below 130° C., so that we may suppose that it is only in the absence of a sufficient quantity of carbonate of lime that a portion of the magnesian carbonate has been converted into magnesite.

(*To be concluded in the next No.*)

ART. XX.—*Extract from the concluding part of a Memoir on the Botany of Japan, in its Relations to that of North America, and of other parts of the Northern Temperate Zone;* by ASA GRAY.*

IT is interesting to notice that, notwithstanding the comparative proximity of Japan to Western North America, fewer of its species are represented there than in far distant Europe. Also,—showing that this difference is not owing to the separation by an ocean,—that far more Japanese plants are represented in Eastern North America than in either. It is, indeed, possible that my much better knowledge of American botany than of European may have somewhat exaggerated this result in favor of Atlantic North America as against Europe, but it could not as against Western North America.

If we regard the identical species only, in the several floras, the preponderance is equally against Western as compared with Eastern North America, but is more in favor of Europe. For the number of species in the Japanese column which likewise occur in Western North America, is about 120: in Eastern North America, 134; in Europe, 157.

Of the 580 Japanese entries, there are which have corresponding

European representatives, a little above	8.48	per cent of identical species,	0.27
Western N. American representatives, about	0.37	" " " "	0.20
Eastern " " "	0.61	" " " "	0.25

* Extracted from the Memoirs of the American Academy of Arts and Sciences, new series, vol. vi.

So geographical continuity favors the extension of identical species; but still Eastern North America has more in common with Japan than Western North America has.

The relations of this kind between the floras of Japan and of Europe are obvious enough; and the identical species are mostly such as extend continuously—as they readily may—throughout Russian Asia, some few only to the eastern confines of Europe, but most of them to its western borders. To exhibit more distinctly the features of identity between the floras of Japan and of North America, and also the manner in which these are distributed between the eastern and the western portions of our continent,—after excluding those species which range around the world in the northern hemisphere, or the greater part of it, or (which is nearly the same thing in the present view), which are unknown in Europe,—I will enumerate the remaining peculiar species which Japan possesses in common with America:—

In Japan.	*In W. N. America.*	*In E. N. America.*
Anemone Pennsylvanica		A. Pennsylvanica
(Coptis asplenifolia?)	C. asplenifolia	
(Trautvetteria palmata)	T. palmata	T. palmata
Caulophyllum thalictroides		C. thalictroides
Diphylleia cymosa		D. cymosa
Brasenia peltata	[B. peltata]	B. peltata
Geranium erianthum	G. erianthum	
Rhus Toxicodendron	R. Toxicod., var.	R. Toxicodendron
Vitis Labrusca (Thunb.)		V. Labrusca
Thermopsis fabacea	T. fabacea	
Prunus Virginiana?		P. Virginiana
Spiræa betulæfolia	S. betulæfolia	S. betulæfolia
Photinia arbutifolia, in Bonin.	P. arbutifolia	
Pyrus rivularis?	P. rivularis	
Ribes laxiflorum	R. laxiflorum	
(Penthorum sedoides, China)		P. sedoides
Cryptotænia Canadensis		C. Canadensis
Heracleum lanatum	H. lanatum	H. lanatum
(Archemora rigida?)		A. rigida
(Archangelica Gmelini)	A. Gmelini	A. Gmelini
Cymopterus littoralis?	C. littoralis	
Osmorrhiza longistylis	O. longistylis	O. longistylis
Echinopanax horridus	E. horridus	
Aralia quinquefolia		A. quinquefolia
Cornus Canadensis	C. Canadensis	C. Canadensis
Viburnum plicatum		V. plicatum (lantanoides
*Achillea Sibirica	*A. Sibirica	
*Artemisia borealis	*A. borealis	*A. borealis
Vaccinium macrocarpon	V. macrocarpon	V. macrocarpon
Menziesia ferruginea	M. ferruginea	M. ferruginea
(Boschniakia glabra?)	B. glabra	
*Pleurogyne rotata	*P. rotata	*P. rotata

In Japan.	*In W. N. America.*	*In E. N. America.*
(Asarum Canadense ?)		A. Canadense
*Polygonum Bistorta	P. Bistorta	
Rumex persicarioides	R. persicarioides	R. persicarioides
Liparis liliifolia		L. liliifolia
Pogonia ophioglossoides		P. ophioglossoides
Iris setosa	I. setosa	
Trillium erectum, var.		T. erectum
(Smilacina trifolia)		S. trifolia
Polygonatum giganteum		P. giganteum
(Streptopus roseus)	S. roseus	S. roseus
Veratrum viride	V. viride	V. viride
Juncus xiphioides	J. xiphioides	
(Cyperus Iria)		C. Iria
Carex rostrata		C. rostrata
Carex stipata	C. stipata	C. stipata
Carex macrocephala	C. macrocephala	
Sporobolus elongatus	S. elongatus	S. elongatus
Agrostis scabra	A. scrabra	A. scabra
Festuca pauciflora	F. pauciflora	
Adiantum pedatum	A. pedatum	A. pedatum
Onoclea sensibilis		O. sensibilis
Osmunda cinnamomea		O. cinnamomea
Lycopodium lucidulum		L. lucidulum
(Lycopodium dendroideum)	L. dendroideum	L. dendroideum

The names enclosed in parentheses are of species which I have not seen from Japan; some of them inhabit the adjacent mainland; some are imperfectly identified. Those marked * are high northern species in America.

Of those 56 extra-European species, 35 inhabit Western, and 41 Eastern North America. And 15 are Western, and not Eastern; 21 Eastern and not Western; and 20 common to both sides of the continent. Eight or ten of these 56 species extend eastward into the interior of Asia.

On the other hand, the only species which I can mention as truly indigenous both to Japan and to Europe, but not recorded as ranging through Asia, are

Euonymus latifolius,	Fagus sylvatica,	Blechnum Spicant,
Valeriana dioica,	Streptopus amplexifolius,	Athyrium fontanum.
Pyrola media,		

Two of these species extend across the northern part of the American continent, and on to the Asiatic; another occurs on the northwest coast of America; and another, the *Fagus*, is represented in Eastern America by a too closely related species. It is noteworthy, that not one of these seven plants is of a peculiarly European genus, or even a Europæo-Siberian genus;—while of the fifty-six species of the Americo-Japanese region wanting in Europe, twenty are of extra-European genera; seven-

teen are of genera restricted to the North American, East Asian, and Himalayan regions (except that *Brasenia* has wandered to Australia); fourteen of the genera (most of them monotypic) are peculiar to America and Japan or the districts immediately adjacent; one is peculiar to our northwest coast and Japan; and eight are monotypic genera wholly peculiar (*Brasenia* excepted) to the Atlantic United States and Japan. Add to these the similar cases of other American species (nearly all of them peculiarly Atlantic-American) which have been detected in the Himalayas or in Northern Asia,—such as *Menispermum Canadense* (*Dauricum*, DC.), *Amphicarpæa monoica? Clitoria Mariana, Osmorrhiza brevistylis, Monotropa uniflora, Phryma leptostachya, Tipularia discolor?* &c.,—and it will be almost impossible to avoid the conclusion, that there has been a peculiar intermingling of the Eastern American and Eastern Asian floras, which demands explanation.

The case might be made yet stronger by reckoning some subgeneric types as equivalent to generic in the present view, and by distinguishing those species or genera which barely enter the eastern borders of Europe; e. g. *Cimicifuga fœtida, Mœhringia lateriflora, Geum strictum, Spiræa salicifolia,* &c.

It will be yet more strengthened, and the obvious conclusion will become irresistible, when we take the nearly allied, as well as the identical, species into account. And also when we consider that, after excluding the identical species, only 15 per cent of the entries in the European column of the detailed tabular view are in italic type (i. e. are *closely* representative of Japanese species); while there are 22 per cent of this character in the American column.

For the latter, I need only advert to some instances of such close representation, as of

Trollius patulus	by	*T. Americanus,*
Aquilegia Burgeriana	"	*A. Canadensis,*
Rhus vernicifera	"	*R. venenata,*
Celastrus scandens	"	*C. articulatus,*
Negundo cissifolium	"	*N. aceroides,*
Sophora Japonica	"	*S. affinis,*
Sanguisorba tenuifolia	"	*S. Canadensis,*
Astilbe Thunbergii & Japonica	"	*A. decandra,*
Mitchella undulata	"	*M. Repens,*
Hamamelis Japonica	"	*H. Virginica,*
Clethra barbinervis	"	*C. acuminata,*
Rododendron brachycarpum	"	*R. Catawbiense,*
Amsonia elliptica	"	*Tabernæmontana,*
Saururus Loureiri	"	*S. cernuus,*

and many others of the same sort,—several of which, when better known, may yet prove to be conspecific; while an equally

large number could be indicated of species which, although more positively different, are yet no less striking counterparts.

To demonstrate the former proposition, I have only to contrast the extra-American genera common to Europe and Japan with the extra-European genera common to North America and Japan. The principal European genera of this category are *Adonis, Epimedium, Chelidonium, Malachium, Lotus, Anthriscus, Hedera, Asperula, Rubia, Carpesium, Ligularia, Lampsana, Picris, Pæderota, Ajuga, Thymus, Nepeta, Lamium, Ligustrum, Kochia? Daphne, Thesium, Buxus, Mercurialis, Cephalanthera, Paris, Asparagus*,—to which may as well be added *Pæonia* and *Bupleurum*, the former having a representative on the mountains, and the latter in the arctic regions, of Western America, but both absent from the rest of our continent. Excepting *Pæderota* and *Buxus* (the latter a rather doubtful native of Eastern Asia), none of these genera are peculiar to Europe, but all extend throughout Asia and elsewhere over large parts of the world.

The following incomplete list of North American genera or peculiar subgeneric types represented in Japan and its vicinity, but unknown in Europe, presents a very different appearance. Those which are absent from the flora of Western North America are italicised.

Trautvetteria
Cimicifuga (barely reaches Europe)
Illicium
Magnolia
Cocculus & Menispermum
Mahonia
Caulophyllum
Diphylleia
Brasenia
Nelumbium
Dicentra
Stuartia (& *Gordonia?*)
Zanthoxylum
Cissus
Ampelopsis
Berchemia
Æsculus
Sapindus
Negundo
Thermopsis
Wistaria
Desmodium
Lespedeza
Rhynchosia
Sophora

Philadelphus
Penthorum
Hammelis
Liquidambar
Cryptotænia
Cymopterus?
Archemora
Osmorrhiza
Aralia & § *Ginseng*
Echinopanax
Diervilla
Mitchella
Oldenlandia
(Siegesbeckia, in Mexico)
Cacalai (reaches E. Europe)
Gaultheria
Leucothoë
Pieris
Clethra
Menziesia
Symplocos
Ardisia
Boschniakia
Catalpa
Tecoma
Dicliptera

Asarum § *Heterotropa*
Phytolacca
Benzoin & *Sassafras?*
Tetranthera
Saururus
Pachysandra
Laportea
Pilea
Bœhmeria
Microptelea
Maclura
Juglans
Abies § Tsuga
Chamæcyparis
Torreya
Arisæma
Arctiodracon
Pogonia
Arethusa
Dioscorea
Aletris
Coprosmanthus
Trillium
Clintonia
Streptopus § Hekorima,
Chamælirium?

Photonia	*Leptandra*	Sporobolus
Astilbe	*Callicarpa*	*Arundinaria*
Mitella	*Cedronella*	Adiantum
Hydrangea	*Amsonia*	*Onoclea*
Itea		

Here are about 90 extra-European genera or forms, 64 of which are absent from Western North America out of the tropics (the latter comprising a very large part of the most striking representative species), and almost as many more are divided between North America and extra-tropical (chiefly Northern and Eastern) Asia. About 40 of the latter are genera or groups of single, or else of two or few closely related species, peculiar, or nearly peculiar, to the regions just mentioned.

This list should be supplemented by those additional North American genera which have one or more closely representative species in the Himalayan region only, such as *Podophyllum*, *Pyrularia*, &c.; and also by the numerous cases in which Eastern American plants are represented in the Himalayo-Japanese region by strikingly cognate, although not congeneric species; such as our *Macrotys* by *Pityrosperma*; *Schizandra* by *Kadsura* and *Sphærostema*; *Neviusia* by *Kerria* and *Rhodotypus*; *Calycanthus* by *Chimonanthus*; *Cornus florida* by *Benthamia*; *Prosartes* by *Disporum*; *Helonias* by *Heloniopsis*; and so of others, which have been mentioned in the former part of this memoir, and exhibited in the accompanying tabular view.

I had long ago, in Silliman's Journal, presented some data illustrative of this remarkable parallelism, and also more recently in my "Statistics of the Flora of the Northern United States" (vol. xxii, second series); where I had noticed the facts,—1. that a large percentage of our extra-European types are shared with Eastern Asia; and 2, that no small part of these are unknown in Western North America. But Mr. Bentham was first to state the natural conclusion from all these data,—though I know not if he has even yet published the remark,—viz., that the interchange between the temperate floras even of the western part of the Old World and of the New has mainly taken place *via* Asia. Notwithstanding the few cases which point in the opposite direction (e. g. *Eriocaulon septangulare*, *Spartina*, *Subularia*, *Betula alba*), the general statement will be seen to be well sustained. Also, in the Journal of the Proceedings of the Linnæan Society, 2. p. 34, Mr. Bentham "calls to mind how frequently large American genera (such as *Eupatorium*, *Aster*, *Solidago*, *Solanum*, &c.) are represented in Eastern Asia by a small number of species, which gradually diminish or altogether disappear as we proceed westward toward the Atlantic limits of Europe; whilst the types peculiar to the extreme west of Europe (excluding of course the Arctic flora) are wholly deficient in America.

These are among the considerations which suggest an ancient continuity of territory between America and Asia, under a latitude, or at any rate with a climate, more meridional than would be effected by a junction through the chains of the Aleutian and the Kurile Islands."

I shall presently state why connection in a more meridional latitude need not be supposed.

The deficiency in the temperate American flora of forms at all peculiar to Western Europe is almost complete, and is most strikingly in contrast with the large number of Eastern American forms repeated or represented in Eastern Asia. Of genera divided between Eastern North America and Europe, I can mention only *Ostrya*, *Narthecium*, *Psamma*, the maratime *Cakile*, and perhaps *Scolopendrium*. *Hottonia* might have been added, but for a species accredited to Java. And if we extend the range across our continent, we add only *Cercis* and *Lœflingia*. Of the ampler genera at all characteristic of the European flora, I can enumerate from the Flora of the Northern United States nothing more important than *Helianthemum* and *Valerianella*, two or three species of each, (but those of the former hardly congeners of the European ones,) adding that *Hieracia* and perhaps *Cirsia* are somewhat more plentiful in Eastern than in Western America. Let it also be noted, that there are even fewer Western-European types in the Pacific than in the Atlantic United States, notwithstanding the similarity of the climate!

That representation by allied species of genera peculiar, or nearly peculiar, to two regions, furnishes evidence of similar nature and of equal pertinency with representation by identical species, will hardly be doubted. Whether or not susceptible of scientific explanation, it is certain that related species of phænogamous plants are commonly associated in the same region, or are found in comparatively approximate (however large) areas of similar climate.* Remarkable exceptions may indeed be ad-

* The fundamental and most difficult question remaining in natural history is here presented;—the question whether this actual geographical association of congeneric or other nearly related species is primordial, and therefore beyond all scientific explanation, or whether even this may be to a certain extent a natural result. The only noteworthy attempt at a scientific solution of the problem, aiming to bring the variety as well as the geographical association of existing species more within the domain of cause and effect, is that of Mr. Darwin and (later) of Mr. Wallace,—partially sketched in their short papers "On the Tendency of Species to form varieties, and on the Perpetuation of Varieties and Species by natural Means of Selection," in the Journal of the Proceedings of the Linnæan Society, vol. iii. (Zoölogy), p. 45. The views there suggested must bear a prominent part in future investigations into the distribution and probable origin of species. It will hardly be doubted that the tendencies and causes indicated are really operative; the question is as to the extent of their operation. But I am already disposed, on these and other grounds, to admit that what are termed closely related species may in many cases be lineal descend-

duced, but the fact that they are remarkable goes to confirm the proposition. Indeed, the general expectation of botanists in this regard sufficiently indicates the common, implicit opinion. The discovery of a new *Sarracenia* or a new *Halesia* in the Atlantic United States, or of a new *Eschscholtzia*, *Platystemon*, or *Calais* west of the Rocky Mountains, would excite no surprise. A converse discovery, or the detection of any of these genera in a remote region, would excite great surprise. The discovery of numerous closely related species thus divided between two widely separated districts might not, in the present state of our knowledge, suggest former continuity, migration, or interchange; but that of identical species peculiar to the two inevitably would.

Why should it? Evidently because the natural supposition is that individuals of the same kind are descendants from a common stock, or have spread from a common centre; and because the progress of investigation, instead of eliminating this preconception from the minds of botanists, has rather confirmed it. Every other hypothesis has derived its principal support from difficulties in the application of this. A review of what has been published upon the subject of late years makes it clear that the doctrine of the local origin of vegetable species has been more and more accepted, although, during the same period, species have been shown to be much more widely dispersed than was formerly supposed. Facts of the latter kind, and the conclusions to which they point, have been most largely and cogently brought out by Dr. Hooker, and are among the very important general results of his extensive investigations. And the best evidence of the preponderance of the theory of the local origin of species, notwithstanding the great increase of facts which at first would seem to tell the other way,—is furnished by the works of the present De Candolle upon geographical botany. This careful and conscientious investigator formerly adopted and strenuously maintained Schouw's hypothesis of the double or multiple origin of species. But in his great work, the *Géographie Botanique Raisonnée*, published in the year 1855, he has in effect discarded it, and this not from any theoretical objections to that view, but because he found it no longer needed to account for the general facts of distribution. This appears from his qualified, though dubious, adherence to the hypothesis of a double origin, as a *dernier ressort*, in the few and extraordinary cases which he could hardly explain in any other way. His decisive instance, indeed, is the occurrence of the Eastern American *Phryma leptostachya* in the Himalaya Mountains.

ants from a pristine stock, just as domesticated races are; or, in other words, that the limits of occasional variation in species (if by them we mean primordial forms) are wider than is generally supposed, and that derivative forms when segregated may be as constantly reproduced as their originals.

The facts presented in the present memoir effectually dispose of this subsidiary hypothesis, by showing that the supposed single exception belongs to a not uncommon case. Indeed, so many species are now known to be common to Eastern and Northern Asia and Eastern North America,—some of them occurring also in Northwestern America and some not,—and so many genera are divided between these two regions, that the antecedent improbability of such occurrence is done away, and more cases of the kind may be confidently expected. However others may regard them, it is clear that De Candolle would now explain these cases in accordance with the general views of distribution adopted by him, under which they naturally fall,—so abandoning the notion of a separate creation.

I know not whether any botanist continues to maintain Schouw's hypothesis. But its elements have been developed into a different and more comprehensive doctrine, that of Agassiz, which should now be contemplated. It may be denominated the *autochthonal* hypothesis.

In place of the ordinary conception, that each species originated in a local area, whence it has been diffused, according to circumstances, over more or less broad tracts,—in some cases becoming widely discontinuous in area through climatic or other physical changes operating during a long period of time,—Professor Agassiz maintains, substantially, that each species originated where it now occurs, probably in as great a number of individuals occupying as large an area, and generally the same area, or the same discontinuous areas, as at the present time.

This hypothesis is more difficult to test, because more ideal than any other. It might suffice for the present purpose to remark, that, in referring the actual distribution, no less than the origin, of existing species to the Divine will, it would remove the whole question out of the field of inductive science. Regarded as a *philosophical* question, Maupertuis's well known "principle of least action" might be legitimately urged against it; namely, "that it is inconsistent with our idea of Divine wisdom, that the Creator should use more power than was necessary to accomplish a given end." This philosophical principle holds so strictly true in all the mechanical adaptations of the universe, as Professor Peirce has shown, that we cannot think it inapplicable to the organic world also, and especially to the creation of beings endowed with such enormous multiplying power, and such means and facilities for dissemination, as most plants and animals. Why then should we suppose the Creator to do that supernaturally which would be naturally effected by the very instrumentalities which he has set in operation?

Viewed, however, simply in its *scientific* applications to the question under consideration, (the distribution of plants in the

temperate zone of the northern hemisphere,) the autochthona hypothesis might be tested by inquiring whether the p rimitiv or earliest range of our species could possibly have remained unaffected by the serious and prolonged climatic vicissitudes to which they must needs have been subject; and whether these vicissitudes, and their natural consequences, may not suffice to explain the partial intermingling of the floras of North America and Northern Asia, upon the supposition of the local origin of each species. Let us bring to the inquiry the considerations which Mr. Darwin first brought to bear upon such questions, and which have been systematically developed and applied by the late Edward Forbes, by Dr. Hooker, and by Alphonse De Candolle.

No one now supposes that the existing species of plants are of recent creation, or that their present distribution is the result of a few thousand years. Various lines of evidence conspire to show that the time which has elapsed since the close of the tertiary period covers an immense number of years; and that our existing flora may in part date from the tertiary period itself. It is now generally admitted that about 20 per cent of the Mollusca of the middle tertiary (miocene epoch), and 40 per cent of the pliocene species on the Atlantic coast still exist; and it is altogether probable that as large a portion of the vegetation may be of equal antiquity. From the nature of the case, the direct evidence as respects the flora could not be expected to be equally abundant. Still, although the fossil plants of the tertiary and the post-tertiary of North America have only now begun to be studied, the needful evidence is not wanting.

On our northwestern coast, in the miocene of Vancouver's Island, among a singular mixture of species referable to *Salix*, *Populus*, *Quercus*, *Planera*, *Diospyros*, *Salisburia*, *Ficus*, *Cinnamomum*, *Personia*, or other *Proteaceæ*, and a Palm (the latter genera decisively indicating a tropical or subtropical climate), Mr. Lesquereux has identified one existing species, a true characteristic of the same region ten or fifteen degrees farther south, viz., the Redwood or *Sequoia sempervirens*. In beds at Somerville referred to the lower or middle pliocene by Mr. Lesquereux, this botanist has recently identified the leaves of *Persea Carolinensis*, *Prunus Caroliniana*, and *Quercus myrtifolia*, now inhabiting the warm sea-coast and islands of the Southern States.*

The pliocene quadrupeds of Nebraska also show that the climate east of the Rocky Mountains at this epoch was much warmer than now. About the Upper Missouri and Platte there were then several species of Camel (*Procamelus*) and allied Ruminantia and a Rhinoceros, besides a Mastodon, an Elephant, some Horses

* These and other data, obligingly communicated by Mr. Lesquereux, have been published in the May number of the American Journal of Science and Arts.

and their allies, not to mention a corresponding number of carnivorous animals. These herbivora probably fed in a good degree upon herbage and grasses of still existing species. For herbs and grasses are generally capable of enduring much greater climatic changes, and are therefore likely to be even more ancient than trees. These animals must have had at least a warm-temperate climate to live in: so that in lat. 40°–43° they could not have been anywhere near the northern limit of the temperate flora of those days; indeed the temperate flora, which now in Western Europe touches the Arctic Circle, must then have reached equally high latitude in Central, or Western North America. In other words, the temperate floras of America and Asia must then have been conterminous (with small oceanic separation), and therefore have commingled, as conterminous floras of similar climate everywhere do.

At length, as the post-tertiary opened, the glacier epoch came slowly on,—an extraordinary refrigeration of the northern hemisphere, in the course of ages carrying glacial ice and arctic climate down nearly to the latitude of the Ohio. The change was evidently so gradual that it did not destroy the temperate flora, at least not those enumerated above as existing species. These and their fellows, or such as survive, must have been pushed on to lower latitudes as the cold advanced, just as they now would be if the temperature were to be again lowered; and between them and the ice there was doubtless a band of subarctic and arctic vegetation,—portions of which, retreating up the mountains as the climate ameliorated and the ice receded, still scantily survive upon our highest Alleghanies, and more abundantly upon the colder summits of the mountains of New York and New England;—demonstrating the existence of the present arctic-alpine vegetation during the glacial era; and that the change of climate at its close was so gradual that it was not destructive to vegetable species.

As the temperature rose, and the ice gradually retreated, the surviving temperate flora must have returned northward *pari passu*, and—which is an important point—must have advanced much farther northward, and especially northwestward, than it now does; so far, indeed, that the temperate floras of North America and of Eastern Asia, after having been for long ages most widely separated, must have become a second time conterminous. Whatever doubts may be entertained respecting the existence of our present vegetation generally before the glacial era, its existence immediately after that period will hardly be questioned. Here, therefore, may be adduced the direct evidence recently brought to light by Mr. Lesquereux, who has identified our live oak (*Quercus virens*), Pecan (*Carya olivæformis*), Chinquapin (*Castanea pumila*), Planer-tree (*Planera Gme-*

lina), Honey-Locust (*Gleditschia triacanthos*), *Prinos coriaceus*, and *Acorus Calamus*,—besides an elm and a *Ceanothus* doubtfully referable to existing species,—on the Mississippi, near Columbus, Kentucky, in beds which Mr. Lesquereux regards as anterior to the drift. Professor D. D. Owen has indicated their position "as about 120 feet lower than the ferrugineous sand in which the bones of the *Megalonyx Jeffersonii* were found." So that they belong to the period immediately succeeding the drift, if not to that immediately preceeding it. All the vegetable remains of this deposit, which have been obtained in a determinable condition, have been referred, either positively or probably, to existing species of the United States flora, most of them now inhabiting the region a few degrees farther south.

If, then, our present temperate flora existed at the close of the glacial epoch, the evidence that it soon attained a high northern range is ready to our hand. For then followed the second epoch of the post-tertiary, called the *fluvial* by Dana, when the region of St. Lawrence and Lake Champlain was submerged, and the sea there stood five hundred feet above its present level; when the higher temperate latitudes of North America, and probably the arctic generally, were less elevated than now, and the rivers vastly larger, as shown by the immense upper alluvial plains, from fifty to three hundred feet above their present beds; and when the diminished breadth and lessened height of northern land must have given a much milder climate than the present.

Whatever the cause, the milder climate of the fluvial epoch is undoubted. Its character, and therefore that of the vegetation, is decisively shown, as geologists have remarked, by the quadrupeds. While the *Megatherium*, *Mylodon*, *Dicotyles*, &c. demonstrate a warmer climate than the present in the Southern and Middle United States, the *Elephas primigenius*, ranging from Canada to the very shores of the Arctic Ocean, equally proves a temperate climate and a temperate flora in these northern regions. This is still more apparent in the species of the other continent, where, in Siberia, not only the *Elephas primigenius*, but also a Rhinoceros, roamed northward to the arctic sea-coast. The quadrupeds that inhabited Europe in the same epoch are well known to indicate a warm-temperate climate as far north as Britain, in the middle, if not the later post-tertiary. North America then had its herds of Mastodons, Elephants, Buffaloes or Bisons of different species, Elks, Horses, *Megalonyx*, the Lion, &c.; and, from the relations between this fauna and that of Europe, there is little doubt that the climate was as much milder than the present on this as on the other side of the ocean. All the facts known to us in the tertiary and post-tertiary, even to the limiting line of the drift, conspire to show that the difference between the two continents as to temperature was very nearly the same then

as now, and that the isothermal lines of the northern hemisphere curved in the directions they now do.

A climate such as these facts demonstrate for the fluvial epoch would again commingle the temperate floras of the two continents at Behring's Straits, and earlier—propably through more land than now—by way of the Aleutian and Kurile Islands. I cannot imagine a state of circumstances under which the Siberian Elephant could migrate, and temperate plants could not.

The fluvial was succeeded by the "*terrace* epoch," as Dana names it, "a time of transition towards the present condition, bringing the northern part of the continent up to its present level, and down to its present cool temperature,"*—giving the arctic flora its present range, and again separating the temperate floras of the New and of the Old World to the extent they are now separated.

Under the light which these geological considerations throw upon the question, I cannot resist the conclusion, that the extant vegetable kingdom has a long and eventful history, and that the explanation of apparent anomalies in the geological distribution of species may be found in the various and prolonged climatic or other physical vicissitudes to which they have been subject in earlier times;—that the occurrence of certain species, formerly supposed to be peculiar to North America, in a remote or antipodal region affords of itself no presumption that they were originated there;—and that the interchange of plants between Eastern North America and Eastern Asia is explicable upon the most natural and generally received hypothesis, (or at least offers no greater difficulty than does the Arctic flora, the general homogeneousness of which round the world has always been thought compatible with local origin of the species,) and is perhaps not more extensive than might be expected under the circumstances. That the interchange has mainly taken place in high northern latitudes, and that the isothermal lines have in earlier times turned northward on our eastern, and southward on our northwest coast, as they now do, are points which go far towards explaining why Eastern North America, rather than Oregon and California, has been mainly concerned in it, and why the temperate interchange, even with Europe, has principally taken place through Asia.

Brasenia peltata.—To the remarks upon the known range of of this species, I have now to add the interesting fact, that it exists upon the northwestern coast of America, having been gathered by Dr. Pickering, in Wilkes's South Sea Exploring Expedition, in a stream which falls into Gray's Harbor, lat. 47°. It must be

* For the collocation and communication of the geological data here presented, I am indebted to the kindness of my friend, Professor Dana.

local on the western side of the continent, or it would have been met with before. When this remarkable plant was known to occur only in Eastern North America and Eastern Australia, it made the strongest case in favor of double creation that perhaps has ever been adduced. But since it has been found to occur throughout the Eastern Himalayas and in Japan, and has now been detected in Northwestern America also, the case seems to crown the conclusions to which this memoir arrives.

ART. XXI.—*Supplement to an Enumeration of North American Lichens, continued;* by EDWARD TUCKERMAN, A.M., Professor of Botany in Amherst College.

THE species follow each other, as before, in the order of the arrangement proposed by Dr. Nylander, who has studied these plants in the light afforded by a knowledge which includes not only the external, but all the microscopical details. Some species, not North American as yet known, but of more or less interest in connection with our flora, are added in brackets.

COLLEMA APALACHENSE, Tuck. in litt., thallo stellato multifido imbricato crassiusculo fusco-viridi, laciniis plano-convexis apice subteretibus obtusis rugulosis, subtus pallidis; apotheciis innato-sessilibus planis rufescentibus margine integerrimo. Sporæ ellipsoideæ 3-septatæ diam. vix duplo longiores. Lime-rocks, Hancock county, Alabama, *Hon. T. M. Peters.*

COLLEMA TEXANUM, sp. nova, thallo orbiculari substellato imbricato crasso luteo-virescente, laciniis radiantibus elongatis subplanis profunde pinnato-laceris papulosis; apotheciis sparsis planiusculis rufis margine tumido integro. Sporæ minimæ fusiformes uniseptatæ.—Trees, Texas, *Mr. Charles Wright.* Resembles the more perfect forms of C. pulposum. Spores exceedingly small. I am indebted, for their detection and delineation, to my friend, the Rev. J. L. Russell.

LEPTOGIUM CRENATELLUM, sp. nova, thallo imbricato tenerrimo glauco-cinerascente, laciniis rotundatis crenatis denticulatis; apotheciis minusculis creberrimis sessilibus convexis pallido-fuscescentibus margine tenui pallescente subintegro evanescente. Sporæ ellipsoideæ 5-septatæ.—On trees in swamps, Brattleborough, Vermont, *Mr. C. C. Frost.*

LEPTOGIUM JUNIPERINUM, Tuck. in litt., thallo pusillo suborbiculari imbricato tenui plumbeo e lobis rotundatis adscendentibus crenatis subtus ad margines albo-fibrillosis; apotheciis sesilibus plano-convexis margine tenui demum evanido discum rufofuscum cingente. Sporæ ellipsoideæ apicibus acutæ 3-septatæ. —On the earth in cedar woods, Texas. *Mr. Wright.*

Calicium Curtisii, sp. nova, thallo byssaceo nigro (vel obsoleto) apotheciis minutis turbinatis disco subnitido nigro stipitibus brevibus ex albido rufescentibus demum nigris. Sporæ majusculæ ellipsoideæ vel elongato-ellipsoideæ (dactylinæ, *Koerb.*) fuscescentes simplices.—On the living bark of Rhus typhina, in Berkshire, Massachusetts; and of Robinia Pseudacacia, at the Hot Springs, Virginia, *Rev. Dr. Curtis.* The stipes like those of Calicium or Coniocybe nigricans, Fr. (not of Tuckerm. Synops. Lich. N. E. which is C. subtile, on Bark) but the apothecia quite different, and the spores very much larger than in that species; as in C. eusporum, Nyl., to which, and C. byssaceum, Fr., the lichen is probably nearest.

Bæomyces absolutus, sp. nova, thallo crustaceo effuso tenuissimo submembranaceo læteviridi; apotheciis stipitatis incarnatis planis disco demum convexiusculo marginem tenuem excludente. Sporæ ellipsoideæ simplices hyalinæ. Biatora icmadophila, var. stipitata, Tuckerm. in litt. ad cel. Montagne.—On the earth, Alabama, *Mr. Peters.* [Mountains of Cuba, *Mr. Wright.* Venezuela, *Mr. Fendler.*] Representing possibly, in tropical America, both B. ericetorum (B. roseus, Auctt.) and B. æruginosus (Biat. icmadophila, Auctt.) but nearest to the last, which it seems to connect, naturally, with the first.

[Cladonia dactylota, sp. nova, thalli squamulis amplis erectis subtus albo-pulverulentis podetia gracilescentia cylindrica membranaceo-corticata lævigata viridi-pallescentia e margine proferentibus, scyphis angustatis margine subincurvis denticulatis demum oblique prolifero-palmatis; apotheciis carneo-fuscescentibus.

Var. β, *symphycarpia*, podetiis elongatis scyphis subintegris (vel obsoletis) apotheciis conglomeratis.

Var. γ, *sorediata*, podetiis hinc inde, scyphisque, vel his obliteratis apicibus clavatis cornutisve sorediis pulvinatis albis adspersis.—On the earth in the mountains of Cuba, *Mr. Wright.* Venezuela, *Mr. Fendler.* Differs from C. fimbriata as C. digitata differs from C. deformis. The primary form is hardly distinguishable from C. digitata, except in being whiter, and in the color of the apothecia. The white, cushion-like, powdery soredia, which, in what seems to be the commonest state, take the place of the apothecia, and are scattered over the smooth podetia (in the latter case appearing clearly to be deliquescent squamules) make perhaps the most striking, however an abnormal feature of this elegant Cladonia.]

Stereocaulon nanodes, sp. nova, podetiis pumilis erectis cæspitoso-conglomeratis subnudis validis tereti-compressis a basi vage apicemque versus fastigiato-ramosis albidis, phyllocladiis ad apices confertis e rotundato-subsquamaceis glaucis demum

pulverulentis; apotheciis terminalibus dilatatis demum convexis. Sporæ generis. S. nanum, Tuck. Synops. N. E. p. 46, pr. p.—Rocks near water, (Crystal Falls; Saco Falls; Upper Gorge of the Ammonoosuck) in the White Mountains. S. nanum of European authors (Fr. Lich. Suec. n. 59; Schær. Lich. Helv. n. 588; Moug. and Nestl. Crypt. Vog. n. 647) appears to be an atypical condition, and has not yet occurred with us, but I have hitherto taken the present as representing the perfect state of the species. The full development of our lichen seems however to indicate a different affinity, and to separate it from the section (Chondrocaulon, Th. Fr.) which includes S. nanum. It is perhaps rather nearer to S. denudatum.

Sterocaulon chlorellum, sp. nova, podetiis pumilis erectis glabris nitidis subcompressis lacunosis stramineis fastigiato-ramosis, phyllocladiis ad apices confertis minutis rotundatis mox deliquescentibus pulverulentis; apotheciis . . . . .—Rocks, Islands of Behring's Straits, *Mr. Wright.* At once distinguishable by its minuteness, smoothness, and pale-yellow or straw color. The granules (phyllocladia, Th. Fr.) are exceedingly small. The apothecia are as yet unknown.

Stereocaulon? Wrightii, sp. nova, thallo cæspitoso cartilagineo subfoliaceo glaucescente, ramis laciniæformibus adscentibus extrorsum latioribus inciso-ramosis crenatis margine inflexis crispatis supra viridescentibus subtus nervosis tenuiter tomentosis; cephalodiis majusculis pulvinatis viridi-nigrescentibus plicato-rugosis demum floccosis; apotheciis . . . . —Rocks, Islands of Behring's Straits, *Mr. Wright.* With the habit of erect states of Squamaria chrysoleuca, but the cephalodia of Stereocaulon. It is perhaps not impossible that these little understood developments should occur outside of the present genus, or that this lichen should be *sui generis.* The crisped margins take often the shape of Parmeliaceous apothecia, thus increasing the general resemblance of the plant to a Squamaria. But it has also evident points of similarity to Stereocaulon? pulvinatum, Ach., an obscure Cape of Good Hope lichen, for specimens of which I am indebted to Dr. Sonder of Hamburg. The apothecia of this last also are unknown.

[Alectoria Japonica, sp. nova, thallo subcæspitoso tereti rigido sorediis albis exasperato stramineo, ramis sterilibus ramosissimis implexis attenuatis subfilamentosis, fertilibus simpliciusculis incrassatis, apicibus nigricantibus; apotheciis subterminalibus superficiali-sessilibus appendiculatis disco concavo demum expanso plano nitido castaneo. Sporæ majusculæ ellipsoideæ limbatæ viridi-fuscescentes demum subhyalinæ.—On dead pine trees, Ayan, Japan, *Mr. Wright.* Nearest to A. ochroleuca, but differing very much in habit, and in fructification. The spores are not very unlike those of Pertusaria pertusa.]

[Ramalina dasypoga, sp. nova, thallo filamentoso rigidiusculo fragili tereti lævigato viridi-fuscescente (pallescente) ramis elongatis dichotome ramosis ultimis acuminatis nodulosis; apotheciis concavis demum planis repandis margine tenui incurvo subcrenulato disparente. Sporæ ellipsoideæ uniseptatæ curvulæ hyalinæ diam. duplo longiores.—On trees and rocks in the mountains of Cuba, *Mr. Wright.* Allied to R. usneoides (Ach.) Nyl., which has also been found in Cuba, by the same unwearied collector, but differs in its regularly terete thallus, larger apothecia, &c. It is still more like a pendulous Usnea, or perhaps Alectoria; but possesses the spores of the present genus.]

Cetraria Californica, sp. nova, thallo cæspitoso cartilagineo anguloso lacunoso-subcanaliculato opaco e viridi fuscescente, ramis irregulariter subdichotome ramosis patentibus, fertilibus superne incrassatis; apotheciis terminalibus appendiculatis margine dentato-fimbriatis demum convexis nigris.—On the bark of trees, Monterey, California, *Menzies.* Fronds in small, roundish masses, many branches diverging from a single base, with the aspect rather of a small, slender state of Ramalina calicaris, β, than of the erect Cetrariæ, to which, and in particular C. tristis and C. aculeata, it is indeed, if I mistake not, nearest allied. The station, upon trees, and on the coast of California, is a very unlikely one for C. aculeata, from which the present also differs remarkably in habit of growth, and in color. Though more than seventy years have passed since the venerable botanist who gave me these specimens collected them, they appear to be undescribed.

Sticta Ravenelii, sp. nova, thallo pusillo suborbiculari membranaceo appresso scrobiculato viridi-glaucescente (fuscescente) laciniis elongatis sinuato-lobatis crenatis (glomerulis fruticulosis viridibus nunc aspersis) subtus fuscescentibus tomentosis; apotheciis sparsis margine inflexo persistente crenulato-sublobato. Sporæ elongato-fusiformes 1–3-septatæ virescentes diam. 12–20-plo longiores.—Trees, in the low country of South Carolina, *Mr. Ravenel;* Alabama, on trees, *Mr. Peters;* and also on rocks (the specimen dark brown), *Mr. Beaumont;* Mississippi, *Dr. Veitch;* Louisiana, *Dr. Hale;* (Cuba, *Mr. Wright.*)—A smaller plant than either of the two species of this group, of the northern hemisphere, with much the lobation of S. glomerulifera, but the texture of S. herbacea, and distinguished, so far as my specimens go, from both, by its strongly pitted upper surface, and its crenulate-lobate apothecia, which rather approach those of some of the tropical members of the group, as S. pallida, Hook. The glomerules appear only on a Cuban specimen. They are quite like those of S. glomerulifera, but the largest do not exceed a line in diameter. The spores are more elongated than those of the species just mentioned, and appear to be differently septate.

[STICTA WRIGHTII, sp. nova, thallo subcoriaceo adpresso lævigato viridi-glaucescente, laciniis rotundatis sinuato-incisis crenatis subtus fuscis ambitu pallescentibus tomentosis, cyphellis plano-concavis albis; apotheciis sparsis elevatis extus mammillatis e concavo margine inflexo demum planis margine irregulari subevanescente. Sporæ late fusiformes uniseptatæ limbatæ virescentes diam. c. 5-plo longiores.—On beech trunks, mountain sides, Hakodadi, Japan, *Mr. Wright.* With the apothecia, and the general aspect of S. glomerulifera, but differing in a rather more loose habit of lobation, it which it approaches nearer to the broader forms of S. damæcornis; in its spores; and most remarkably, in possessing in abundance, regular cyphellæ; which resemble those of S. fuliginosa, though also occurring urceolate, as in S. damæcornis. The genus Ricasolia, De Not., was originally constituted, to include the natural group of species to which the present belongs, on a mistaken comparison of the apothecia of these species, with certain abnormal apothecia common in other species of Sticta, which are now regarded, since the publication of Mr. Tulasne's important researches, as morbid conditions, infested by a parasitic cryptogam. (Tulasne, Mém. sur les Lichens, p. 123, note.) The species included in the group, agreeing as they do in many obvious features, were also once supposed to be destitute of cyphellæ, and the greater part, and in particular, the tropical ones, probably are so; but Fries and Delise testify to the occurrence of this development, however rarely, in both the old species of the northern hemisphere, while in the Japanese lichen, above-described, it is normal. This species may not improbably be found to occur also in North America.]

[PHYSCIA? WRIGHTII, sp. nova, thallo orbiculari imbricato tenui molliusculo polito pallide viridi (glaucescente) subtus albo venis minusculis prominulis villosis reticulato, hypothallo nunc crassiusculo byssaceo-lanuginoso cinerascente, laciniis planis irregulariter multifido-lacinulatis, ambitu latioribus palmatis, centro plus minus excrescentiis isidiomorphis cylindricis obsitis; apotheciis subcentralibus sessilibus disco plano luteolo margine crasso incurvo crenulato cincto demum flexuosis. Sporæ . . . . —On trunks of trees in dense woods, in the mountains of Cuba, *Mr. Wright.* With the habit of Physcia, but also a good deal resembling Parmelia ambigua. The species appears to be undescribed.]

LECANORA ASCOCISCANA, Tuck. herb. Psoroma, Tuckerm. suppl. &c. in Amer. Journ. Sci., xxv, p. 424. There is something in this curious lichen which suggests a near affinity to Psoroma, as the genus is constituted by Dr. Nylander, but the fuscescent, often a little curved and kidney-shaped, one-septate

spores indicate its true place in Lecanora, where it long stood in my herbarium. The spores resemble those (I owe the suggestion to Dr. Nylander) of L. sophodes, but the lichen is very distinct.

[LECANORA CAMPALEA, sp. nova, thallo crustaceo tartareo verrucoso-subplicato lævigato viridi-glaucescente (pallescente) hypothallo nigro insigni limitato; apotheciis appressis demum flexuoso-irregularibus disco tumente e rufo fusco-nigrescente margine thallode integro pallente. Sporæ suboctonæ elongato-fusiformes 5-pluriseptatæ diam. 10–15 plo longiores hyalinæ.—Trees, Island of Cuba, *Mr. Wright.* The affinity of this elegant lichen to L. ventosa is indicated, no less by the spores than by the external characters.]

[BIATORA RHODOPIS, sp. nova, thallo crustaceo effuso tenui cartilagineo-membranaceo lævigato rimuloso limitato glauco-cinerascente, intus miniato; apotheciis sessilibus hinc inde aggregatis demum difformibus margine tumidulo integerrimo lævi mox flexuoso saturate roseo discum subplanum nudum rufo-nigrescentem hypothecio crassiusculo nigro impositum cingente. Sporæ suboctonæ ellipsoideæ simplices diam. duplo longiores hyalinæ.—On bushes in the Island of Cuba, *Mr. Wright.* Differs remarkably from described species, but has somewhat of the general aspect of L. domingensis.

BIATORA VIRELLA, sp. nova, thallo crustaceo effuso incrustante subtartareo rugoso-granulato glauco-sulphureo, humecto viridi; apotheciis sessilibus margine tenui pallidiori integerrimo mox flexuoso evanido discum planoconvexum rufo-fuscescentem cingente. Sporæ minusculæ ellipsoideæ subfusiformes diam. triplo longiores hyalinæ.—On rocks in dense woods, in the mountains of Cuba, *Mr. Wright.* With the habit of L. glebulosa.

BIATORA PYRRHOMELÆNA, sp. nova, thallo e granulis minutis rotundatis mox subsquamaceis imbricatis glaucescentibus intus miniatis hypothallum crassum rufo-nigricantem ad ambitum prominentem interrupte obtegentibus; apotheciis ex hypothallo oriundis subplanis margine tenuissimo erecto flexuoso rufo-nigrescente discum nigrum nitidum hypothecio rufo impositum cingente, dein conglomeratis convexis marginem excludentibus. Sporæ minutæ ellipsoideæ simplices hyalinæ.—On trunks of trees near the ground, in the mountains of Cuba, *Mr. Wright.* Near to B. parvifolia, but differing as described.

BIATORA PHÆASPIS, sp. nova, thallo crustaceo effuso e granulis subsquamaceis mox corallinis pallide ochroleucis; apotheciis appressis rufo-fuscis flexuosis disco demum convexo marginem obtusum pallidiorem excludente. Sporæ fusiformi-cylindricæ 1–4-septatæ diam. 3–4-plo longiores hyalinæ.—Trees, Cuba, *Mr. Wright.* Also resembling B. parvifolia in general appearance,

but the spores connect the lichen rather with B. vernalis. It does not appear to be described.]

GYROSTOMUM CURTISII, Tuckerm. suppl. in Amer. Journ. Sci., xxv, p. 430, a determination made upon high authority, is referred by my friend Mr. Russell to Lecidea; and the spores, as his sketch fully shows, indicate that the lichen is probably only a small form of L. disciformis (L. parasema, Fr. *a*) in which the apothecia are a little urceolate. G. urceolatum is also referred to Lecidea by Dr. Nylander (Enum. Gen., p. 127) but seems to me to be remarkably distinguished by the structure of the apothecium, and the vermicular spores.

ART. XXII.—*On the Phenomena of Gemmation.—Lecture before the meeting of the Royal Institution of Great Britain, by* THOMAS H. HUXLEY, F.R.S.*

THE speaker commenced by stating that a learned French naturalist, M. Duvau, proposed many years ago, to term the middle of the eighteenth century, "l'Époque des Pucerons:" and that the importance of the phenomena which first brought to light by the study of these remarkable insects renders the phrase "Epoch of Plant-lice," as applied to this period, far less whimsically inappropriate than it might at first sight seem to be.

After a brief sketch of the mode of life of these Plant-lice, or *Aphides*, as they are technically termed; of the structure of their singular piercing and sucking mouths; and of their relations to what are called "Blights;" the circumstances which have more particularly drawn the attention of naturalists to these insects were fully detailed.

It was between the years 1740 and 1750, in fact, that Bonnet, acting upon the suggestions of the illustrious Reaumur, isolated an *Aphis* immediately after its birth, and proved to demonstration, that not only was it capable of spontaneously bringing forth numerous living young, but that these and their descendants, to the ninth generation, preserved a similar faculty.

Observations so remarkable were not likely to pass unheeded; but notwithstauding the careful sifting which they have received, Bonnet's results have never been questioned. On the contrary, not only have Lyonet, Degeer, Kyber, Duvau, and others, borne ample testimony to their accuracy, but it has been shown that, under favorable conditions of temperature and food, there is practically no limit to this power of a sexual multiplication, or as it has been conveniently termed, "Agamogenesis."

* From the Proceedings of the Royal Institution of Great Britain, May, 1858,

Thus Kyber bred the viviparous *Aphis Dianthi* and *Aphis Rosæ* for three years in interrupted succession; and the males and true oviparous females of the *A. dianthi* have never yet been met with. The current notion that there is a fixed number of broods, "nine or eleven," is based on a mistake.

As, under moderately favorable conditions, an *Aphis* comes to maturity in about a fortnight; and as each *Aphis* is known to be capable of producing a hundred young, the number of the progeny which may eventually result from a single *Aphis* during the six or seven warm months of the year is easily calculated. M. Tougard's estimate adopted, (and acknowledged) by Morren, and copied from him by others, gives the number of the tenth brood as one quintillion. Supposing the weight of each *Aphis* to be no more than $\frac{1}{1000}$th of a grain, the mass of living matter in this brood would exceed that in the most thickly populated countries in the world.

The agamogenetic broods are either winged or wingless. The winged forms at times rise into the air, and are carried away by the wind in clouds; and these migrating hordes have been supposed to be males and females, swarming like the ants and bees! During the summer months it is unusual to meet other than viviparous *Aphides*, whether winged or wingless; but ordinarily, on the approach of cold weather, or even during warm weather, if the supplies of food fall short, the viviparous *Aphides* produce forms which are no longer viviparous, but are males and oviparous females. The former are sometimes winged, sometimes wingless. The latter, with a single doubtful exception, are always wingless.

The oviparous females lay their eggs, and then, like the males, die. It commonly happens also that the viviparous *Aphides* die, and then the eggs are left as the sole representatives of the species; but in mild winters many of the viviparous *Aphides* merely fall into a state of stupor and hybernate, to re-awake with the returning warmth of spring. At the same time the eggs are hatched and give rise to viviparous *Aphides*, which run through the same course as before. The species *Aphis*, therefore, is fully manifested not in any one being or animated form, but by a cycle of such, consisting of,—1st. the egg; 2nd, An indefinite succession of viviparous *Aphides;* 3rd, Males and females eventually prodeced by these, and giving rise to the egg again.

If, armed with the microscope and scalpel, we examine into the minute nature of these processes (without which inquiry all speculation upon their nature is in vain), we find that the viviparous *Aphis* contains an organ similar to the ovarium of the oviparous female, in some respects, but differing from it, as Von Siebold was the first to show, in the absence of what are termed

the colleterial glands and the spermatheca—organs of essential importance to the oviparous form.

In the terminal chambers of this "Pseud-ovarium," ovum-like bodies, thence called "pseud-ova," are found. These bodies pass one by one into the pseudovarian tubes, and there gradually become developed into young, living *Aphides*. As Morren has well said, therefore, the young *Aphides* are produced by "the individualization of a previously organized tissue."

The only organic operation with which this mode of development can be compared, is the process of budding or gemmation as it takes place in the vegetable kingdom, in the lower forms of animal life, and in the process of formation of the limbs and other organs of the higher animals. And the parallel is complete if such a plant as the bulbiferous lily or the *Marchantia*, or such an animal as the *Hydra*, is made the term of comparison.

Thus agamogenesis in *Aphis*, is a kind of internal budding or gemmation. If we inquire how this process differs from multiplication by true ova or "Gamogenesis," we find that the young ovum in the ovarium is also, to all intents and purposes, a bud, indistinguishable from the germ in the pseudovarium of the agamogenetic *Aphis*. Histologically there is no difference between the two; but there is an immense qualitative or physiological difference, which cannot be detected by the eye, but becomes at once obvious in the behavior of the two germs after a certain period of their growth. Dating from this period, the pseudovum spontaneously passes into the form of an embryo, becoming larger and larger as it does so; but the ovum simply enlarges, accumulates nutritive matter, acquires its outer investments, and then falls into a state of apparent rest, from which it will never emerge, unless the influence of the spermatozoon have been brought to bear upon it.

That the vast physiological difference between the ovum and the pseudovum should reveal itself in the young state by no external sign, is no more wonderful than that primarily the tissue of the brain should be undistinguishable from that of the heart.

The phenomena which have been described, were long supposed to be isolated, but numerous cases of a like kind, some even more remarkable, are now known.

Among the latter, the speaker cited the wonderful circumstances attending the production of the drones among bees, as described by Von Siebold; and he drew attention to the plant upon the table, *Cœlobogyne ilicifolia*, a female euphorbiaceous shrub, the male flowers of which have never yet been seen, and which nevertheless, for the last twenty years, has produced its annual crop of fertile seeds in Kew Gardens.

Not only can we find numerous cases of agamogenesis similar to that exhibited by *Aphis* in the animal and vegetable worlds,

but if we look closely into the matter, agamogenesis is found to pass by insensible gradations into the commonest phenomena of life. All life, in fact, is accompanied by incessant growth and metamorphosis; and every animal and plant above the very lowest attains its adult form by the development of a succession of buds. When these buds remain connected together, we do not distinguish the process as anything remarkable; when on the other hand, they become detached and live independently, we have agamogenesis. Why some buds assume one form and some another, why some remain attached and some become detached, we know not. Such phenomena are for the present the ultimate facts of biological science; and we cannot understand the simplest among them, it would seem useless, as yet, to seek for an explanation of the more complex.

Nevertheless, an explanation of agamogenesis in the *Aphis* and in like cases has been offered. It has been supposed to depend upon "the retention unchanged of some part of the primitive germ-mass;" this germ-mass being imagined to be the seat of a peculiar force, by virtue of which it gives rise to independent organisms.

There are however two objections to this hypothesis: in the first place, it is at direct variance with the results of observation; in the second, even if it were true, it does not help us to understand the phenomena. With regard to the former point, the hypothesis professes to be based upon only two direct observations, one upon *Aphis*, the other upon *Hydra;* and both these observations are erroneous, for in neither of these animals is any portion of the primitive germ-mass retained, as is said to be, in that part which is the seat of agamogenesis.

But suppose the fact to be as the hypothesis requires; imagine that the terminal chamber of the pseudovarium is full of nothing but "unaltered germ-cells;" how does this explain the phenomena? Structures having quite as great a claim to the title of "unaltered germ-cells" lie in the extremities of the acini of the secreting glands, in the sub-epidermal tissues and elsewhere; why do not they give rise to young? Cells, less changed than those of the pseudovarium of *Aphis*, and more directly derived from the primitive germ-mass, underlie the epidermis of one's hand; nevertheless, no one feels any alarm lest a nascent wart should turn out to be an heir.

On the whole, it would seem better, when one is ignorant, to say so, and not to retard the progress of sound inquiry by inventing hypotheses involving the assumption of structures which have no existence, and of "forces" which, their laws being undetermined, are merely verbal entities.

ART. XXIII.—*On Earthquakes in Southern Italy, by* JAMES PHILIP LACAITA, Esq., LL.D.*

SOUTHERN Italy is celebrated for its delightful climate, its matchless scenery, its great historical associations; but it has also a less enviable renown; it is the classic ground of volcanoes and earthquakes. Etna and Vesuvius are the two most active volcanoes in Europe, and terrific earthquakes have often desolated vast districts of the country.

Though the common origin, to a certain extent, of the agents producing the phenomena of volcanoes and earthquakes is now scarcely questioned, considerable difference of opinion still prevails with regard to the real nature and character of those agents. It is for men of science to determine whether those agents are to be found in the internal heat of the earth which is supposed to arise from a state of fusion; or in the heat produced by chemical combinations and changes; or in the currents of electricity circulating on the earth's crust; or in any other causes whatsoever. On this *vexata quæstio* much light will no doubt be thrown before long by the observations made on the spot by Mr. Mallet, the distinguished author of the "Dynamics of Earthquakes," who, on the first news of the late earthquake in Southern Italy in December last, was sent thither by the Royal Society, for the pursuit of scientific enquiry. Without entering, however, into the field of science, the object of the speaker was to give the members of the Royal Institution a short account of six great earthquakes, without counting minor ones, which within the memory of man laid waste extensive tracts of the kingdom of Naples and caused great loss of life; and especially of the last earthquake, which took place on the night of the 16th of December, 1857.

1. On the 5th of February, 1783, at 1 P. M., the Piana di Monteleone, in the province of Calabria Ultra I, was convulsed by a violent shock of earthquake, which in less than two minutes levelled to the ground 109 towns and villages, and buried 32,000 out of 166,000 inhabitants under the ruins of their houses. A repetition of the shock at midnight ruined the towns of Reggio and Messina, and convulsed the whole Valdemone. At the entrance of the Faro Straits, the sea, retiring from the Calabrian shore and afterwards rushing back with overwhelming violence, swept away more than 1500 inhabitants of the town of Scylla, who had taken refuge on the beach for safety. After a succession of slight shocks, on the 28th of the following March, another violent shock convulsed the whole country from Reggio to Cape Colonna, an area of 1200 square miles, and added two

* From the Proceedings of the Royal Institution of Great Britain, May, 1858.

thousand more to the number of victims. Mountains were cleft asunder, high cliffs tumbled down, rivers turned from their bed or dammed in their course, lakes formed, valleys lifted up into hills, deep chasms opened, the physical aspect of the country changed, all distinctions of property altered. For twenty days a thick pestilential fog set over the desolated country; epidemic fevers followed in summer; and at the beginning of 1784 Calabria had already lost more than 80,000 inhabitants. From February to December 1783, there were no less than 949 shocks, and 151 in 1784; they did not altogether cease till 1786.

2. The mountain of Frosolone, in the province of Molise, the ancient *Samnium*, on the 26th of July, 1804, at 10½ P. M., was the centre of a violent shock of earthquake, which lasted 35 seconds, and caused great desolation over an area of 600 square miles. It ruined 61 towns and villages, and crushed to death more than 6000 people. It was severely felt as far as Naples, where all the buildings were greatly injured by its effects.

3. On the 29th of April, 1835, and on several successive days, the Val di Crati, in the province of Calabria Citra, including the town of Cosenza and its numerous villages, was convulsed by violent shocks of earthquake, which caused the death of more than 1000 people under the ruins.

4. On the 12th of October, 1836, the districts of Rossano and Castrovillari, in the same province, and the district of Lagonegro, in Basilicata, felt another violent shock of earthquake, which swept away more than 600 inhabitants.

5. The city of Melfi, built on a spur of Mount Vulture, an extinct volcano in the province of Basilicata, on the 14th of August, 1851, was the focus of a violent earthquake, which, besides Melfi itself, ruined Barile, Rapolla, and many other towns, and was felt as far as Naples on the western, and Brindisi on the eastern coast. The first shock, at 2 P. M., lasted 20 seconds; the second shock, at 3 P. M., lasted only five seconds. The loss of human life exceeded 1400; Melfi alone, out of 9274, lost 1093 inhabitants.

6. But worse than any of the latter earthquakes, and second only to the Calabrian one of 1783, was the earthquake which took place on the 16th of December last, at 10¼ P. M., at a season of the year, which, by a comparison of all the known dates of earthquakes, has been ascertained to be more subject to disturbances than any other. The sky was clear, the air still; indeed unusual stillness had prevailed the whole of that day. A sharp undulatory shock of 20 seconds' duration, immediately preceded and accompanied by an appalling hollow rumbling noise, had scarcely awaked the inhabitants, who, according to the early habits of provincial life had already retired to rest, when after a hardly perceptible pause of about three minutes, a second and

most violent successive and whirling shock of 25 seconds' duration crushed thousands of them under the ruins of their falling houses. Three other shocks were felt on that awful night, and many others on the following days; but none nearly so violent and so destructive as the two former ones. For nearly two months a slight shock was felt almost periodically just before sunrise. On the 7th of March, about 3 P. M., a violent shock, second only to those of the 16th of December, was felt, which caused considerable injury; and, according to the latest accounts, up to the 28th of April last, the shocks, though comparatively slight and harmless, still continued, and the people were in a state of constant alarm. Such was also the case in every one of the five previous earthquakes that have been noticed; the violence of the hidden agents at work was not at once exhausted by the first great shocks, but continued slightly to shake the ground for months, and sometimes, as in the Calabrian earthquake of 1783, for nearly four years afterwards.

The seat of this earthquake was in the central group of mountains in the provinces of Basilicata and Principato Citra, part of the main chain of the Apennines, which are the watershed between the streams flowing into the Tyrrhenian, the Ionian, and the Adriatic sea, and form the upper basins of the Calore or Tanagro, the Sele, the Ofanto, the Bradano, the Basento, the Sinno, and the Agri rivers. The centre of action, as far as it can be judged from the intensity of its terrific effects, was almost in the heart of the province of Basilicata, in a group of compact limestone mountains of the cretaceous period, the southern branch of the said central group, which running from north to south between the heads of the valleys of the Sinno and the Agri on the east, and the valley of Diano on the west, swells farther south into the lofty peaks of Monte Cocuzzo, Monte del Papa, and Monte Pollino, on the frontiers of Calabria. On the declivities or lower peaks of this group, which are covered with beds of tertiary marine marl sands and conglomerate, and within a district extending over an area of about 216 square miles, stand, or rather stood, the towns and villages of Montemurro, Saponara, Viggiano, Tramutola, Marsico Vetere, Marsico Nuovo, Spinosa and Sarconi, with an aggregate population of 35,570. Out of this number more than 12,000, or more than one-third, in less than half a minute were crushed to death; two thousand severely wounded! The ground was cracked and convulsed in the strangest manner; chasms and deep fissures were opened in several places, fertile hills became bare rocks, valleys were raised up, small pools formed, mountains cleft by deep ravines. The towns of Montemurro and Saponara especially were nearly entirely swept away; the former lost 5600 out of 7000, and the latter 3000 out of 4000 inhabitants. Saponara, which rose in

the middle ages out of the ancient *Grumentum*, where Hannibal sustained a slight defeat by the Consul Claudius Nero, was almost entirely levelled with the ground; there remain only a few shattered houses standing. Of Montemurro, originally a Saracenic settlement of the tenth century, literally nothing was left but a heap of rubbish. On the morning of the 17th of December, 5600 of its inhabitants were dead or dying under the ruins, 685 disabled by wounds; the few remaining unhurt found themselves torn from their dearest ones, houseless, amidst a mass of ruins, without means of subsistence or help, and exposed to all the inclemency of a severe winter on a high peak of the Apennines! A few days later the stench of the dead human beings under the ruins made life unbearable to the few surviving ones! Both at Montemurro and Saponara, most of the houses standing on beds of conglomerate had been overturned, or shuffled in the strangest manner, and the ruins deposited in the ravines beneath; the contents of the lower stories were, in several instances thrown up into the stories above, or scattered into different directions, as if propelled by a central force. The scenes of misery and horror that took place in those doomed towns exceed what imagination can fancy. Viggiano came next, a town whose inhabitants from time immemorial have been in the habit of wandering, with their harps over different parts of the world, and return home with their savings in summer. It lost 1700 out of 6634 inhabitants, and had most of the houses and churches overthrown. At this place an extensive fire added to the horrors of the night.

From the centre of a triangle formed by these three towns, on which the fury of the convulsion was more violently wreaked, the distances, in a direct line, are,—to the Gulf of Policastro, 24 miles; to Pæstum, on the Gulf of Salerno, 58 miles; to the mouth of the Agri, on the Gulf of Tarentum, 47 miles; to the extinct volcano of Mount Vulture, 55 miles; to Mount Vesuvius, 94 miles; to Bari, on the Adriatic, 80 miles; and to Mount Etna, 195 miles.

Beyond this district, the terrific effects of the earthquake extended, though somewhat diminished in intensity, over an area of more than 3000 square miles, destroying or injuring, more or less, about 200 towns and villages, with an aggregate population of more than 200,000 inhabitants, of whom no less than 10,000 were killed.

Within this area the beautiful and fertile valley of Diano, through which flows the Tanagro, a tributary of the Sele, traversed in its length by the high road leading into Calabria, and enlivened on both sides by numerous towns and villages built on the top or the slope of the hills, was sadly desolated. Polla is said to have lost 2000 out of 7060 inhabitants; Padula, 500

out of 9000; Pertosa, 218 out of 1100; Sassano, 185 out of 3600; Montesano, 420 out of 4800, &c. Leaving the valley of Diano, and proceeding northwards to the head of the vallley of the Sele, will be found Brienza, Calvello, St. Angelo Le Fratte, Picerno, Tito, Potenza, the capital of Basilicata, etc., with most of their houses and public buildings ruined, and many of their inhabitants killed. At Tito, in particular, more than 300 out of 4939 inhabitants were crushed to death, and its beautiful Norman cathedral totally thrown to the ground. South of Potenza, in the upper valleys of the Bradano, the Basento and the Agri, and eastward of the center of action, Laurenzana, Corleto, Guardia, Aliano, Armento, Gallicchio, Missanello, Sant' Arcangelo, Castelsaraceno, and numerous other towns and villages, had most of the houses thrown down, and many inhabitants killed.

But the effects of this terrific earthquake extended far beyond the large era that has just been noticed. The two shocks of the 16th were felt, with various degrees of intensity, as far as the town of Reggio in Calabria on the south, Brindisi on the Adriatic, on the east, Vasto, also on the Adriatic, on the north, and Terracina on the west. Within these limits many towns had their buildings much injured, and some inhabitants killed. All the towns on the Adriatic, from Polignano to Manfredonia, had their buildings rent. At Canosa, 15 houses were thrown down, 155 more rendered uninhabitable, and 5 persons were killed. At Melfi and Barile, there were three deaths. In the neighborhood of Bella, a town which stands half way between Potenza and Melfi, a tract of about 600 acres was split in different directions, and surrounded with a chasm 15 feet deep, and about as wide. At Salerno, many public buildings were injured, and 4 persons killed. Even at Tramonti, near Amalfi, there were two deaths; and at Naples, the inhabitants were so greatly alarmed by the violence of the shocks, as to spend in the open air all the night of the 16th of December.

On the whole, by this terrific earthquake, at least 22,000 human beings, on a most moderate calculation, were destroyed in a few seconds. Many no doubt would have been saved had it been possible by active steps to dig them out immediately. This will account for the comparatively very small number of wounded, in all about 4000.

From the above data it will be seen that in the course of 75 years, from 1783 to 1857, the kingdom of Naples lost at least 111,000 inhabitants, by the effects of earthquakes, or more than 1500 per year, out of an average population of six millions!

Several touching anecdotes were told in the course of the narrative. In 1783, Eloisa Basili, a beautiful girl of 16, was buried under the ruins with a child in her arms, who died on the fourth

day. She was so wedged in that she could not get rid of its lifeless remains. She was dug out alive after eleven days, which she had counted from a ray of light that reached her. She recovered, but remained sad and gloomy, could not bear to see a child, would neither marry nor become a nun. She preferred solitude, turned away with a shudder from houses, and liked to sit musing under a tree, whence no buildings were seen. She pined away, and died at five-and-twenty.

More fortunate was the lot of Marianna De' Franceschi, a beautiful young lady of 20, who, in the earthquake of 1804, was dug out at Guardia Regia, after being buried for ten days and eight hours. She recovered, married, and became the mother of a numerous family.

A lady with child was dug out after 30 hours by her devoted husband, who nearly died from over-fatigue. On being asked what her thoughts were during the time, she answered, "I was waiting."

In the late earthquake, a gentleman of Montemurro, whilst escaping from the house with his wife and a large family of children, remembered that one of them had been left in bed. He rushed back to take him, but the house tumbling on every side, he remained alone on a wall. All his family were crushed to death. The blow was too great; his mind gave way, and he went raving mad. At Saponara, the judge was buried under the ruins of his house with his young wife and two children. He was dug out alive, but his wife was found dead lying across his knees with her arms outstretched towards her dead children. He was overwhelmed by his loss; ever since he has diligently fulfilled the duties of his office, but has never been heard to allude to the event, or seen to smile.

Instances were mentioned, showing how tenacious life could be under the most trying circumstances. Besides the cases of Basili and De' Franceschi already recorded, in 1783 a baby was dug out alive on the third day, and lived. At Montemurro, in December last, Maria Antonia Palermo and her two little girls, one of them only thirteen months old, were dug out on the eighth day, and lived. With some animals the length of time they had stood alive was quite remarkable. A donkey was found living yet on the fifteenth day; and in 1783 two mules and a chicken were found still alive on the twenty-second, and two pigs on the thirty-second day.

Art. XXIV.—*Notes on some of the Chemical Reactions of Strychnia;* by T. G. Wormley, M.D.

In the following paper it is proposed to give the result of some experiments in regard to the relative value of the various tests which have been suggested for the detection of strychnia.

The various solutions were made with great care from pure strychnia dissolved in just sufficient quantity of acetic acid, and the reagents were generally applied by means of a glass rod dipped in a saturated solution of the reagent, to a *single drop* of the strychnia solution delivered, upon a glass slide, from a graduated burette which furnished a fluid grain in each drop. Therefore, each drop contained an amount of pure strychnia, corresponding to the fractional dilution of the solution.

1. *Ammonia Test.*

1. $\frac{1}{100}$ grain of pure strychnia in one grain of water, gives with ammonia, an immediate white precipitate, which at first is amorphous, but very soon it begins to assume a crystalline form, and in about three minutes the drop becomes a solid mass of lengthened prisms.

2. $\frac{1}{500}$ gives an immediate precipitate, but in a few seconds beautiful stellate crystals begin to form, which very soon become abundant.

3. $\frac{1}{1000}$, behaves much the same as No. 2, not so abundant.

4. $\frac{1}{2500}$, with the microscope, crystals begin to form in about a minute, in three minutes they are very obvious to the naked eye. If the drop be rubbed with a glass rod, rings of granules are very obvious to the eye in a few seconds, and the precipitate is much more abundant than when not thus treated.

5. $\frac{1}{5000}$, no indications after stirring for several minutes, except when viewed with the microscope, a few granules appear.

From the above experiments, the limit of the ammonia test, when applied to a single drop, is when it holds in solution $\frac{1}{2500}$ its weight of strychnia; however, at this degree of solution the result is very satisfactory.

2. *Potash.*

This reagent behaves much the same as ammonia, its limit being about the same. In applying this test it is important that the proper quantity be added, for if either too much or to little, no precipitate will be produced.

3. *Carbonate of Potash.*

1. $\frac{1}{100}$ grain of strychnia with carbonate of potash gives an immediate white precipitate of star-like crystals, which will redissolve if sufficient quantity of the reagent has not been added.

2. $\frac{1}{500}$, in a few seconds small granules, prisms, and a few stellate crystals begin to form, which after a little time are rather abundant.

3. $\frac{1}{1,000}$, in a few seconds lengthened granules may be seen with the microscope, which in a few minutes are very obvious to the naked eye.

4. $\frac{1}{2,000}$, after a few minutes small granules are very perceptible.

5. $\frac{1}{5,000}$, after several minutes no indications with the microscope.

4. *Carbonate of Ammonia.*

In $\frac{1}{100}$ and $\frac{1}{500}$ solutions the same results as with carbonate of potash. In a drop of $\frac{1}{1,000}$ solution no indication after 15 minutes.

5. *Iodid of Potassium.*

1. $\frac{1}{100}$ solution in a few seconds gives a white crystalline precipitate of tufts of long prisms.

2. $\frac{1}{500}$, it is several minutes before crystals begin to form, if the solution be stirred, however, they begin to appear in about two minutes.

3. $\frac{1}{1,000}$, by stirring, the crystals begin to appear in about five minutes.

4. $\frac{1}{2,000}$, crystals begin to form in about seven minutes.

5. $\frac{1}{5,000}$, crystals can be observed with the microscope in about 10 minutes, in 20 minutes they are just perceptible to the naked eye.

6. *Sulphocyanid of Potassium.*

1. $\frac{1}{100}$, solution, gives an immediate mass of white crystals.

2. $\frac{1}{500}$, in a few seconds the crystals are very abundant.

3. $\frac{1}{800}$, by rubbing, in less than a minute the crystals are very obvious.

4. $\frac{1}{1,000}$, by rubbing, in a few minutes the crystals begin to form.

5. $\frac{1}{2,000}$, no indication after several minutes, with the microscope a few crystals may be observed upon the border of the drop.

7. *Tannic Acid.*

1. $\frac{1}{10,000}$, gives an immediate white curdy precipitate.

2. $\frac{1}{25,000}$, gives very good results.

3. $\frac{1}{30,000}$, after a few minutes the precipitate is quite perceptible.

4. $\frac{1}{40,000}$, after several minutes it is just possible to observe a white cloudiness.

The satisfactory limit of the test is when it is applied to a drop of fluid holding in solution $\frac{1}{25,000}$ its weight of strychnia.

The precipitate is very soluble in acetic acid, and if obtained from dilute solutions, it is, also, soluble in a drop of potash, giving a red liquid; but when produced from strong solutions, the precipitate will not all dissolve in a drop of potash solution.

8. *Bichlorid of Platinum.*

1. $\frac{1}{1000}$, an immediate yellow amorphous precipitate which soon becomes granular.

2. $\frac{1}{2000}$, an amorphous precipitate in a few moments, which soon becomes granular.

3. $\frac{1}{5000}$, the results are very good in a few minutes.

4. $\frac{1}{10,000}$, if the solution be rubbed, small granules begin to appear in a few minutes, and soon the result is satisfactory.

9. *Terchlorid of Gold.*

1. $\frac{1}{1000}$, gives a bright yellow amorphous precipitate, which soon becomes partly granular; most of the granules float upon the surface of the drop. A portion of the precipitate collects into little yellow flakes.

2. $\frac{1}{2000}$, gives much the same reaction as No. 1, not so abundant.

3. $\frac{1}{10,000}$, gives an almost immediate precipitate.

4. $\frac{1}{50,000}$, gives very satisfactory results.

5. $\frac{1}{40,000}$, at this degree of dilution the precipitate is still perceptible, but not satisfactory.

When the precipitate obtained from a solution containing $\frac{1}{2000}$ or less of its weight of strychnia is boiled, the precipitate will dissolve and give a yellow solution, from which it will again be deposited, with little or no change upon becoming cool. If the solution contains more than $\frac{1}{5000}$ its weight, the precipitate will not entirely dissolve upon boiling, after cooling there will generally be a metallic gilding upon the sides of the tube. The precipitate from $\frac{1}{5000}$ or more dilute solutions, will readily dissolve, without much change of color, upon the addition of a drop or two of potash solution; if then the mixture be boiled it will give a fine purple color, with sometimes a purple precipitate. When the precipitate is from a stronger solution than above stated, it does not readily dissolve in a solution of potash, and when the mixture is boiled it behaves as above.

10. *Chromate of Potash.*

1. $\frac{1}{100}$, gives an immediate mass of yellow crystals, soluble in 30 drops of strong acetic acid.

2. $\frac{1}{1000}$, crystals begin to form in a few seconds, but they are not very abundant after standing 15 minutes.

3. $\frac{1}{2000}$, with the microscope, a few prisms may be observed in 8 minutes, but no indication to the eye, after standing 20 minutes.

11. *Carbazotic Acid.*

This, and the three following tests have been formerly recommended in the lectures of the writer, the only account of them seen, is in the last edition of Taylor on Poisons, in which the iodine test is suggested.

An alcoholic solution of carbazotic acid will give with—

1. $\frac{1}{100}$, grain of strychnia, an immediate amorphous yellow precipitate soon becoming twig-like tufts.

2. $\frac{1}{1000}$, in a few seconds a precipitate soon becoming as in No. 1.

3. $\frac{1}{2000}$, by rubbing a few seconds, a copious deposit of granules.

4. $\frac{1}{10,000}$, in about a minute the same as No. 3.

5. $\frac{1}{20,000}$, in a few minutes small granules are very obvious.

12. *Bichromate of Potash.*

1. $\frac{1}{100}$, an immediate brilliant yellow mass of dendroidal crystals.

2. $\frac{1}{1000}$, in a few seconds same as No. 1.

3. $\frac{1}{2500}$, crystals begin to form in a few seconds, in a few minutes they are abundant.

4. $\frac{1}{10,000}$, in a few minutes beautiful octahedra appear, resembling those of oxalate of lime. If the solution be rubbed the deposit becomes rather abundant.

5. $\frac{1}{15,000}$, by rubbing, in a few minutes crystals are obvious with the microscope, in several minutes they are readily seen with the eye.

The precipitate produced by this reagent is not as readily soluble in acetic acid, as that produced by the protochromate of potash.

13. *Iodine.*

Of the various tests recommended for strychnia, this is the most delicate. It was applied in the following experiments, by dissolving three grains of iodid of potassium in one fluid drachm of water, and then adding to the mixture one grain of iodine.

1. $\frac{1}{1000}$, immediately a copious brownish yellow amorphous precipitate soluble in alcohol and ether, but only soluble in large excess of acetic acid. The precipitate partially dissolves in a few drops of potash solution, but it is immediately replaced by a dirty white precipitate.

2. $\frac{1}{2000}$, the precipitate entirely dissolves in potash, and is replaced by the white one.

3. $\frac{1}{20,000}$, gives same results as No. 2, not so abundant.

4. $\frac{1}{30,000}$, the precipitate dissolved in potash gives a very faint white precipitate.

5. $\frac{1}{40,000}$, the precipitate is immediately produced and soon collects into little yellow flakes.

6. $\frac{1}{100,000}$, if the drop be touched with a small drop of the reagent upon the end of a glass rod, it gives an obvious precipitate.

If a few drops of the last named solution be placed in a small test tube, and a drop of the test fluid be placed upon the inside and allowed to flow into the solution, when they meet, yellow streaks will readily be observed, and the solution will become turbid.

14. *Bromine.*

This reagent was prepared by saturating a strong solution of hydrobromic acid, with bromine.

1. $\frac{1}{1000}$, gives an immediate bright yellow amorphous precipitate.
2. $\frac{1}{10,000}$, a yellow precipitate, having a greenish tinge.
3. $\frac{1}{20,000}$, a dirty yellow precipitate, which after several minutes nearly all dissolves.
4. $\frac{1}{50,000}$, the precipitate is still perceptible, but not satisfactory.

15. *Color Test.*

It is well known, that if strychnia or its salts be dissolved in sulphuric acid, and then a small quantity of bichromate of potash, ferridcyanid of potassium, peroxyd of lead, or of peroxyd of manganese be added, a series of colors are developed. This is known by the name of the "color test." This test succeeds best in thè following manner: place the strychnia, or a drop of the solution evaporated to dryness, in a watch glass, and by its side a drop of strong sulphuric acid, into which a fragment of bichromate of potash is introduced and stirred until it imparts a yellow color, then by inclining the watch glass the colored acid is allowed to flow over the strychnia.

1. $\frac{1}{1000}$ grain of strychnia in one drop of water, gave in a majority of a number of experiments, very satisfactory results, however, in some the reactions were just perceptible. In solutions stronger than the above the results were always good.
2. $\frac{1}{2000}$, in many cases no indication whatever, in others a very faint trace of color was obtained, which however rapidly disappeared. In no instance was the indication such as should be relied upon for medico-legal purposes.
3. $\frac{1}{1000}$ grain, dry, will always give a fine reaction. By allowing the acid to flow upon a portion of the deposit at a time, several indications may be obtained from the same deposit.
4. $\frac{1}{2000}$, dry, in a majority of instances the indications were very good; in some, however, they were very faint. The success of the experiment depends much on the character of the deposit left by evaporating the solution to dryness; sometimes, the principal part of it is in the form of a ring, which when examined with the microscope consists of well defined crystals; at

others, it is a confused mass distributed over the space occupied by the drop. In the latter case the indications will not be nearly so good as in the former.

5. $\frac{1}{10,000}$, dry, in a number of cases manipulated differently, the majority gave no indications, some few gave a slight trace, but in no instance was the indication sufficient.

As the color test is relied upon, perhaps, more than any other for medico-legal purposes, it is important to remember that it is interfered with by the presence of morphia. When one part by weight of strychnia is mixed with—

1. 1 part of morphia, it gives very good results. The colors, however, are not so bright as with strychnia alone.

2. 1½ of morphia, in a very small quantity of this mixture the indication of strychnia is very good, in a larger quantity, about $\frac{1}{30}$ gr., the reaction is just perceptible.

3. 2 of morphia, the indication in a very small quantity is pretty fair, but in about $\frac{1}{50}$ gr. there is only a mere trace.

4. 3 of morphia, in a very small quantity of this mixture, the reaction is just perceptible, but in a larger amount there is no reaction indicative of the presence of strychnia.

Columbus, Ohio, July 18, 1859.

Art. XXV.—*On the Consolidation of Lava on Steep Slopes, and on the Origin of the Conical Form of Volcanoes*; by Sir Charles Lyell, M.A., D.C.L., F.R.S.*

During two recent excursions made in the autumns of 1857 and 1858 to Mount Etna, Sir C. Lyell had an opportunity of examining sections of lava-currents of known date, which had descended steep slopes, and had consolidated thereon in tabular and stony masses, the inclination of which sometimes exceeded 30°. This fact has an important bearing on the theory of "craters of elevation," it having been affirmed by geologists of high authority, that when lavas congeal on a declivity exceeding 5° or 6°, they never form continuous beds of compact stone, but consist entirely of scoriaceous and fragmentary materials.

The origin of such mountains as Etna and Vesuvius had of old been referred to the cumulative effect of a long series of ordinary eruptions, it being seen that reiterated showers of ashes and streams of lava were often poured out from a permanent central vent. This opinion was advocated by Mr. Scrope in his work on volcanoes in 1825, and by Sir C. Lyell in his *Principles of Geology*, after his exploration of Vesuvius and Etna in 1828; both authors considering the injection from below of

* Proc. Roy. Inst. of Great Britain, April, 1859.

melted matter, in the shape of dykes, as part of the cone-making process.

But in place of this simple explanation of the phenomena, Von Buch substituted the following hypothesis: that a vast thickness of horizontal or nearly horizontal sheets of lava and scoriæ, having been first deposited, an expansive force operating from below, exerts a pressure both upwards and outwards, from a central axis towards all points of the compass, so as suddenly to uplift the whole stratified mass, making it assume a conical form; giving rise at the same time, in many cases, to a wide and deep circular opening at the top of the cone, an opening called a "crater of elevation."

In all great volcanoes of which sections can be obtained, there are some layers of compact stone, inclined at angles of 10°, 20°, and sometimes much higher angles, and these beds are often among the uppermost, or last formed of the whole series. Hence it was logically inferred, when once the law above laid down respecting the consolidation of melted matter had been accepted, that every mountain containing such inclined and compact layers, must owe its conical form almost exclusively to the development of mechanical force exerted at the close of the volcanic operations, or after all the alternating lavas and scoriæ were heaped up. The hypothesis of a sudden and violent movement was perhaps the more readily embraced, because it relieved its advocates from the necessity of making unlimited drafts on past time, thousands of centuries being required if lofty cones, like Mount Etna, are to be built up by successive eruptions of ordinary intensity. The magnitude also of certain craters or "calderas" (implying, probably, one or more great explosions, followed by aqueous erosion), and the occasional steepness of the dips of certain lavas, beyond that which is found on the flanks of ordinary cones, (many of which might have been assigned to local dislocation), afforded additional arguments in favor of the new hypothesis. The lecturer then gave a rapid review of the controversy respecting "craters of elevation," stating the objections made to it by English and continental writers, including the late M. Constant Prevost; and he went on to observe that the principal object of this discourse was to show that the law laid down by M. E. de Beaumont, and by the late M. Dufrenoy, as governing the cooling and solidification of lava currents, on steep slopes, has no foundation in fact. Signor Scacchi had already, in 1855, seen and described a compact stony lava which in that year had flowed down the flanks of Vesuvius from near the margin of the great crater to the base of the cone in the Atrio del Cavallo, having a thickness of from 1½ in the upper to 4½ in its lower part, and dipping at angles varying from 32° to 38°. The interior of this current was laid open to view by a rare accident,

namely, the sinking down in the same year (1855) of a certain portion of the north flank of the cone, whereby one side of the new lava stream was engulphed, and a section of the remainder rendered visible. Although this current had cooled on an average declivity of 35°, it was as compact and as free from vesicles as many lavas which have congealed on level ground at the foot of Vesuvius.*

The first exemplification of a similarly inclined stony lava of known date on Mount Etna, described by the lecturer, and of which a pictorial representation was given, occurs in a ravine called the Cava Grande, near Milo, about 17 miles north of Catania, and 7 from the sea, above the level of which it is elevated about 2000 feet. A branch of the lava current of 1689 descending from the Val del Bove, cascaded over the right bank of that ravine 220 feet high, and on cooling, formed a tabular mass more than 16 feet in thickness, inclined at an average angle of about 35°, and concealing the face of the precipice for a width of about 400 feet. The internal structure of this new lava has been exposed to view by the falling down and partial removal of its scoriaceous crust on the left side; a removal caused by the annual waste of the steep bank of the ravine produced by the action of rain, and the torrent which flows at the bottom. The ravine intersects alternating beds of tuff, scoria, and lava, slightly inclined to the east, or seawards, being a series of the older products of Etna. This new and steeply inclined lava consists of three parallel layers, an upper fragmentary and scoriaceous mass about 8 feet thick; a central stony layer, 5 feet thick; and a lower bed consisting of thin strata of fragmentary scoriæ, in all three feet thick, but the bottom part of which is not visible. The compact central portion is a dolerite or trachi-dolerite, containing crystals of feldspar with some olivine, and is of the ordinary specific gravity of trap. It is divided by joints, 9 or 10 feet apart, so that among the fragments detached by denudation, and strewed over the sloping bank and bottom of the ravine, are angular masses of huge size, with a fracture like that of many ancient igneous rocks. The normal thickness of this bed of compact dolerite is 5 feet, where it dips at 32° and 35°, but near the top where it first enters the ravine, and where the inclination increases to 45° and 47°, the thickness is reduced to one-half or 2½ feet; yet when dipping at 47°, it is still not only stony and compact, but there is no breach whatever of continuity in the mass, and not more joints than in the less inclined portion. This branch of the lava of 1689, which has given a new facing to part of the right bank of the Cava Grande, exhibits but slight in-

* This section, seen by Signor Scacchi in 1855, was looked for by Sir C. Lyell, in company with Signor Scacchi in 1857, and found to be totally buried and concealed by the lavas poured out in the early part of that year.

equalities on its surface, appearing almost even when contrasted with the main current of the same date, from the surface of which many parallel and longitudinal ridges project prominently, sometimes 40 feet above their base, and with very steep sides sloping at angles of from 35° to 70°. The dip of the main current is between 10° and 16° east. From this and other examples, it is inferred that wherever the slopes are excessive (between 25° and 45°) the surfaces of the cooling lavas are less rugged than where the melted matter has congealed on more level ground.

Allusion was next made to some lavas which have cascaded over sea-cliffs 500 feet high, between Aci Reale and Santa Tecla. One of these at a place called the Scalazza of Aci Reale, exhibits a longitudinal section of a tabular mass of stony rock 20 feet thick, inclined at angles of 23° and 29°, which is connected uninterruptedly with the main body of the same lava resting on the gently sloping platform above, of which the sea-cliff is the abrupt termination. The above-mentioned highly inclined stony lava is covered as usual by a parallel layer of scoriæ (in this case 12 feet thick) and its base consists of another bed of scoriæ of slight thickness.

Several other sections of modern lavas of Etna, which have not been disturbed in their position since the day of their formation, and which are inclined at angles exceeding 30° were then enumerated. For a detailed account of those, reference was given to a paper by the lecturer, recently published in the *Philosophical Transactions* (Part 2 for 1858, p. 703). Among them is a current, inclined at 35°, occurring in the Cava Secca, a deep valley near Zafarana; and another reposing on the face of the great precipice at the head of the Val del Bove, under the sunk space called "The Cisterna." This remarkable current has a mean inclination of 35°, and the central stony layer is seven feet thick. Above and below are parallel overlying and underlying masses of scoriæ five and seven feet thick respectively. The flanks of the stream have been undermined and denuded by that constant waste which makes the innumerable dikes to stand out in relief on all the precipices surrounding the Val del Bove. Perhaps, also, in this instance, the lateral excavation of the lava may have been assisted by a rush of water like that of 1755, commonly called Recupero's flood, which descended the same precipice, the "Balzo di Trifoglietto." Suggestions were then offered on the probable cause of that singular inundation, which swept in a few hours from near the summit of Etna through the Val del Bove to the sea. The Canon Recupero traced its course, a few months after the event, by following the line of sand and boulders which it had left in its track; and calculated that the volume of water was so great, that, had all the snows of the top of

Etna been melted instantaneously, they could not have furnished enough water for the deluge. He, therefore, concluded that the water was vomited forth from the summit crater itself. Sir C. Lyell conjectures that there may have been masses of ice in the cone during the eruption which is recorded to have accompanied the flood of 1775, and the ice may have been suddenly melted by hot vapors and injected lava. In support of this hypothesis, he mentioned his having ascertained the continued existence, in 1858, of the same glacier which was alluded to by him in the first edition of his *Principles of Geology*, as occurring at the base of the cone, which had been quarried before 1828. This mass of ice the Catanians again quarried, four years ago, to a depth of four feet, without reaching the bottom. It is covered by ten feet of volcanic sand, and this again by lava. The tale of the mountaineers, who assured Recupero that the water of the flood of 1775 was hot, may have been correct, if the origin here assigned it be true.

Some account was next given of the lavas of 1852–53, which were still hot, and emitting columns of vapor at the time of Sir C. Lyell's last visit. They were more voluminous, perhaps, than any ever poured forth from Etna in historical times, except those of 1669, which overflowed a great part of the city of Catania. The narrative of the people of Zafarana, of the manner in which the frontal wall of lava, 30 feet high, and inclined at an angle of 37°, had crept slowly over green pastures and vineyards, and overwhelmed habitations in the suburbs of that town, reminded Sir Charles of similar tales which he had listened to seven weeks before in the Alpine valley of Zermatt, where the great glacier had, in the preceding spring, been pushing onwards with irresistable force, an equally steep mound of stony fragments, forming the frontal moraine by which green meadows, gardens, and chalets had been overwhelmed. A description was then given of the changes brought about by the lavas of 1852–53 in the scenery of the Val del Bove, and in that of the lower Valley of Calanna, in the interval since 1828, when the lecturer first visited Etna. These changes are very striking; the fresh currents having run from the head of the Val del Bove both in a northeast and in a southeast direction for a distance of six miles, with a breadth in each case of two miles, and having been piled up one over the other in some places (as at the Portella of Calanna) to a depth of more than 100 feet. The longitudinal and nearly parallel ridges on the surface of this new lava field are from 20 to 70 feet high; and there is now a black and monotonous wilderness in many places, where, in 1728, there were verdant forests.

One branch of this lava of 1852 cascaded over a precipitous declivity 500 feet high, at the head of the Valley of Calanna, and consolidated at angles of 35°, 45°, and even 49°. The scoriaceous crust having been partially washed off, the surface of a continuous crystalline and stony mass is exposed to view, only moderately vesicular, and having the steep inclinations above alluded to. This same current rests on an older one, that of 1819, which passed down the same steep cliff, and which has at some points a dip of more than 40°.

[The author continues with facts and reasonings similar to what is published in his paper of last year (this Journal, vol. xxvi, p. 214)]:

In conclusion, the lecturer gave a brief sketch of the series of geological events which he supposed to have occurred on the site of Etna since the time of the earliest eruptions, events which may have required thousands of centuries for their development. The first eruptions are believed to have been submarine, occurring probably in a bay of the sea, which was gradually converted into land by the outpouring of lava and scoria, as well as by a slow and simultaneous upheaval of the whole territory. The basalts, and other igneous products of the Cyclopean Islands were formed contemporaneously in the same sea, the molluscous fauna of which approached very near to that now inhabiting the Mediterranean; so much so, that about nineteen-twentieths of the fossil species of the sub-Etnean tertiary strata still live in the adjoining seas. Hence, as that part of Etna which is of subaerial origin is newer than such fossils, the age of the mountain is proved to be, geologically speaking, extremely modern. During the period when the volcano was slowly built up, a movement of upheaval was gradually converting tracts of the neighboring bed of the sea into land, and causing the oldest volcanic and associated sedimentary strata to rise, until they reached eventually a height 1200 feet (and perhaps more) above the sea level. At the same time the old coast line, together with the alluvial deposits of rivers, was upraised, and inland cliffs and terraces formed at successive heights. The remains of elephants, and other quadrupeds, some of extinct species, are found in these old and upraised alluviums. Fossil leaves of terrestrial plants also, such as the laurel, myrtle, and pistachio, of species indigenous to Sicily, have been detected in the oldest subaerial tuffs. At first the cone of Trifoglietto, and probably the lower part of the cone of Mongibello, was built up; still later the cone last-mentioned, becoming the sole centre of activity, overwhelmed the eastern cone, and finally underwent in itself various transformations, including the truncation of its summit, and the formation of the Val del Bove on its eastern flank. Lastly, the phase of lateral eruptions began, which still continues in full vigor.

ART. XXVI.—*Diluvial Striæ on Fragments in Situ;* by O. N. STODDARD, Prof. Nat. Science, Miami University.

WHILE examining a few days since the fossils and the striæ pertaining to the Silurian formation of this vicinity, I discovered gravel, small boulders, and fragments of the underlying rock, very much worn by diluvial agencies and manifestly now lying where they were when striated. They were nearly uncovered some three years since in forming a bed for a railroad; the remaining denudation has been accomplished by the action of the rains upon the unfinished and unprotected bed.

They have been exposed along the road for about fifteen feet, and across nearly the whole breadth. At one point the material was a mass of gravel closely packed, and covering several square feet; at other places fragments of Silurian limestone, mingled promiscuously with small boulders of granite, greenstone, hornblende and quartz, the whole embedded in compact clay. The striated surfaces were in the same plane, and at one point the underlying rock was exposed, also striated. The direction of the grooves varied from 5° to 8° south of east.

No one, I presume, will for a moment entertain the idea, that the one hundred and forty-one pieces composing this bed were transported to this spot, having been striated elsewhere, and accidentally deposited with their surfaces in the same plane, and their grooves substantially parallel. The chances against such an occurrence are so enormous, that we might with safety say, it could not happen except by miracle.

The bearing of this example upon the different theories of diluvial action is obvious. The agency of running water may be dismissed as utterly inadequate to explain the facts in question. Icebergs driven onward by the waves and currents of a palæozoic sea afford a solution but little more plausible. Icebergs might plough up the bottom and scatter the fragments, but could not retain them in place and striate them. It seems necessary to admit that they were firmly frozen into the clay and thus held in position, while some overlying mass slowly ground off their exposed surfaces. If we admit that the bed was frozen during the striating process, then must we also admit that it could not have been covered at that time by any considerable depth of water. It is hardly necessary to state to a geologist, that no known agency so admirably meets all the conditions of this case, and no supposition so satisfies the mind as this, that glaciers once overspread this region, holding the beds underneath frost-bound; and, while their enormous pressure downwards, prevented displacement in an upward direction, their motion towards the south, ground down, not only the rocks in

place, but also these fragments, almost as firmly fixed by frost as the rocks themselves. On examination, a few of the pieces were found to be grooved on the under surface also. In one or two cases the striæ on opposite sides were nearly parallel, but generally inclined at a considerable angle.

Probably these fragments were at first embedded in the glacier and received, while in that position, the scratches on their under surface, but were subsequently detached from the glacier, embedded and frozen in the clay, where they were reduced to the condition in which they were found.

It may not be amiss to remark in conclusion, that striæ are abundant upon the surface rocks of this region, their direction varying from 1° to 11° east of south. The most durable boulders generally exhibit upon one or more of their surfaces distinct traces of the same abrading agency.

Miami University, June 11th, 1859.

ART. XXVII.—*Vibrations in the Waterfall at Holyoke, Mass.;* by Prof. E. S. SNELL, Amherst College.

AT the meeting of the American Scientific Association held in Montreal, August, 1857, I read a paper on the vibrations of the fall at Holyoke, in which I attributed the movement to the rarefaction of air in the tube behind the sheet, this rarefaction being caused by the action of the water, which carries down the adjacent air, and throws it up in foam mostly on the outside of the fall. In that paper I described two modes of vibration which I had observed, that agreed well with the supposition of acoustic pulsations in a tube of air 1008 feet long, and having *two* nodal sections in one case, and *four* in the other. I also stated my impression that I had, many years before, noticed a much slower rate of vibration, which accorded equally well with the existence of *one* nodal section in the tube.

Since the reading of the above-mentioned paper, I have observed the condition of the fall at four different times. In October and November, 1857, I noticed the same rates of vibration very nearly, which I had previously reported. But on the 16th of April, 1859, I found the water four or five feet deep on the edge of the dam, the temperature of the air about 45°, and the number of oscillations only *eighty-two* per minute. Again, on the 25th of July last, I found the water lower than I had seen it before, (less than three inches deep,) and no vibrations, either in the sheet, or the air at the end of the cavity behind it.

There are, therefore, at least *three* very different rates of vibration in this fall, the slowest when the depth of water is greatest,

and the most rapid when it is about one foot deep, the vibrations ceasing altogether when the depth is so small as three inches. In the following tabular statement, the four first columns show at once the facts as they stand connected in the few observations which I have made, and the last column contains the numbers calculated for an open tube 1008 feet long, with *four* nodes for the *third* and *fourth* observations, *two* nodes for the *first*, *second*, and *fifth*, and *one* node for the *sixth*.

	Time of observation.	Temperature of air.	Depth on Dam.	Observ'd No. vibrations per min.	Calculated No. vibr. per. min.
1	July 25, 1857,	80°	2 feet	137	136
2	July 29, "	75	2 "	136	136
3	Aug. 6, "	75	1 "	257	271
4	Oct. 7, "	65	1 "	258	268
5	Nov. 24, "	30	2 "	140	129
6	Apr. 16, 1859,	45	5 "	82	66
7	July 25, 1859,	70	3 inches	none	none

I used the formula in Peirce's Treatise on Sound, $N=n\frac{V}{L}$, where N is the number of vibrations, n the number of nodes, V the velocity of sound, and L the length of the tube. It is observable, that the calculated rates are higher than the observed, in the cases of most rapid vibration, and lower, in those of least rapidity, while in the medium rates, they very closely agree. As to the seventh case, the sheet was so thin, that it was divided into filaments and broken into spray, and the air had free ingress and egress through its whole length; the acoustic tube being thus destroyed, no vibrations could be produced.

Notwithstanding the discrepancies between the numbers in the two last columns, I think the general correspondence between them points to the true nature of the cause, especially when taken in connection with the fact, that the pulsations are noticeable only in the water and in the air,—not at all in the dam itself, nor in the rock or soil immediately adjacent. It must be remembered also, that the pitch of musical pipes does not fully conform to the formulæ, but varies with the breadth of opening and the mode of exciting vibrations.

This seems to be one of the numerous cases, in which the body which excites vibrations in another, is itself thrown into synchronous vibration by reaction, and then, by its own inertia or elasticity, controls the common rate of both. The sheet of water in its descent first produces rarefaction of the enclosed air by removing a part of it. The immediate effect is a collapse of the sheet of water, as well as a rush of air in at the ends. But the inertia of a thick mass of water will prevent its recovering its natural position so soon as if it were thinner; hence, the air-column divides itself into such a number of segments, that the water and the air can adjust their movements to each other.

In a manner somewhat like this, a stream of air from the lips, driven across the embouchure of a flute, excites vibrations in the column of air, with such frequency that it can itself vibrate in unison with it. But, if the stream is blown more and more swiftly, its elasticity will at length be too great for so slow a rate, and then the column will divide into shorter segments, and the two will continue their vibrations harmoniously upon a higher key. A skillful player can in this way by his mere breath produce *six* or *eight* harmonic notes on the flute, when all the holes are closed.

At the time when I witnessed the comparatively slow oscillation of 82 per minute, I was surprised by the great strength of the current of air, as it rushed into the opening at the end of the dam. I could not venture within the passage through the pier, lest I should be swept in behind the sheet; nor could I stand at the entrance of the arch, without bracing myself, by placing both hands on the corners. There was, however, no alternate *outward* blast, but only a lull, or cessation of all motion; which shows, that the excess of air that pours in at every pulse, is carried out again in some other way; and there is no conceivable way for it to escape, except to be driven down by the falling water, and poured up externally in a bed of foam. It had never occurred to me before, that the velocity of the air-current must be greater, the longer the interval between the pulses, since the rarefaction within the tube will be greater nearly in the ratio of the same interval.

In September, 1857, a paper was read before the Boston Society of Natural History, in which objections were made to my view of the source of the vibrations, and the cause assigned for them was the impulse on the rock produced by successive swells of the sheet, extending parallel to the edge of the dam, from one side of the river to the other. If this is the cause, then the vibrations are first excited in the rock, and communicated thence to the air. But the *rock* and *soil* in the immediate vicinity of the Holyoke fall are not perceived to move in the least, while the *air* sways a loose garment back and forth three or four inches, keeping time with the visible and audible pulsations of the sheet of water, and at the end of the tube sometimes rushes so violently, that a man can scarcely stand against it. That alternate swells and contractions cannot exist in a falling sheet of water, and if so, that they cannot cause sensible undulations in the earth, I am not prepared to assert; but I believe that any unbiased observer will find it quite absurd to apply such an explanation to the strong puffing of the air which is usually so noticeable at the Holyoke fall.

Art. XXVIII.—*Caricography;* by Prof. C. Dewey.

(Continued from vol. xxiv, p. 48, Second Series.)

No. 254. *C. alata,* Tor. Mon.

Spica composita; spiculis 5–8, ovalibus, sessilibus, crassis, superne aggregatis, densifloris, infirne staminiferis; fructibus suborbiculatis, interdum obovatis, distigmaticis, subplanis, abrupti brevi-rostratis, bidentatis, lato-alatis, rostro subscabris, squama ovato-lanceolata brevioribus.

Culm 3–4 feet high, smooth, with rough edged leaves; pale green; stigmas two. North Carolina and Georgia—*Torrey;* Florida—*Chapman;* a pine sedge-grass.

255. *C. striata,* Mx. Boott, Illust., No. 141.

Spicis staminiferis, 1–4, sæpe 2, oblongis, cylindraceis, erectis, subrubris, inferioribus sessilibus et brevioribus; pistilliferis 2, raro 1, oblongo-cylindraceis, erectis, bracteatis, densi-floris, suprema sæpe apice staminifera, tristigmaticis; fructibus ovatis acuminatis sub-inflatis brevi-rostratis scabro-pubescentibus nervosis ore bifidis, squama ovata acuta fusca vel sub-rubra albi-marginata duplo longioribus.

Culm 1–2 feet high, erect, stiff, leafy-bracteate, longer than the striate and lanceolate leaves, reddish at the root.

Penn.—*Muhlenberg;* New Jersey—*Torrey* and also *Knierskern;* Florida—*Chapman.*

Confounded with *C. polymorpha,* Muh.; but Dr. Boott found the Florida plant, fully like the others, to be *C. striata* in the Herbarium of Micheaux. This discovery makes a change in its designation: it led also to the other changes. Thus,

C. Halseyana, vol. xi, p. 313, of this Journal, becomes var. 2 of *C. polymorpha,* Muh. Gram. p. 239. Boott, Illust., No. 56. If this change should prove untenable, the original name can be restored. Years after *C. Hals·yana* was named, I found it with different forms, named polymorpha in Muhl. herbarium.

256. *C. utriculata.* Boott. Illust., No. 37.

Spicis staminiferis 3–4, cylindraceis, erectis, gracilibus; pistilliferis 2–4, sæpe 3, longo-cylindraceis magnis subremotis, sæpe apice staminiferis, sessillibus, longo-foliaceo-bracteatis, infirma inferne attenuata et *laxiflora* et sub-pedunculata fructibus tristigmaticis ovati-oblongis vel ovata ellipsoides, cum rostro terati et bifurcato, glabris, subinflatis, stramineis, revorsis, squama lanceolata purpurea, angusta scabro-aristata longioribus.

Culm 2–3 feet high, erect, strong, shorter than the broad stiff rough nodose and reticulate-veined leaves; plant glaucous-green, except the yellowish spikes.

Abundant over the country by streams.

Confounded in our country with *C. ampullacea*, but separated some years since by Dr. Boott in Hook. Flor. Bor. Am.

C. ampullacea var. *utriculata.* Carey in Manual, and this *var.* much the most common.

Var. sparsiflora, Dew. All the spikes long, 3–6 inches, slender, and the pistillate quite loose—flowered and more lax below and attenuated; fruit smaller, and scale longer.

NOTE.—The following changes in the names of some species, already described in this Journal, become necessary, and some corrections.

C. gynocratis, Wormsk. is due to that difficult form, *C. davalliana*, Wahl., vol. x, p. 283 of this Journal, and the characters need to be more full.

C. gyrocratis, Wormsk. Kunze Supp., t. 31.

Spica unica, dioica; pistillifera oblonga sublaxiflora; fructibus sub-ovalibus vel oblongis basin teretibus, nervosis, cum rostro convexo-tereti sub-brevi recto vel sub-recurvo bidentato, maturis sub-horizontalibus, squama ovata acuta paullo longioribus.

Culm 4–6 inches high, roundish, glabrous, sulcate, longer than the strong, linear, sub-recurved leaves.

Wayne Co., N. Y.—*Dr. Sartwell*, as well as Greenland and Alpine Lapland.

C. tenella, Ehrhart, not Schk., is the oldest name of *C. Persoonii*, Sieb., in this Journal, vol. xix, p. 253, Second Series. For synonyms, see also Carey in Manual, 514. This name of Ehrh. is the true designation.

C. lenticularis, Mx. Boott, Illust. No. 76.

Since the description of this species in this Journal, vol. v., p. 175, Second Series, it has been found on the White Mts., N. H., also at Lake Avalanche, N. Y.—*Torrey* and *Gray*. Staminate spike 1, rarely 2; pistillate spikes 2–5, cylindric, obtuse, and distigmatic; fruit oval or ovate, short-rostrate.

ART. XXIX.—*Description of Nine new species of Crinoidea from the Subcarboniferous Rocks of Indiana and Kentucky;* by SIDNEY LYON and S. A. CASSEDAY.

IT was our intention originally, to publish the description of these, and other western Crinoidea, in the fourth volume of the Report on the Geology of Kentucky; but as many of our new and most interesting fossils find their way to the cabinets of European palæontologists and are described by them in continental journals, we determined to lay before the public the results of our labors at the earliest possible moment. We have drawings of all the species described, which we will publish sometime during the winter of the present year.

GONIASTEROIDOCRINUS, n. g., Lyon and Casseday.

Generic Formula.

Basal pieces, 1×5, pentagonal perforation not visible.
Subradial pieces, 5, hexagonal, nearly equal in size.
Primary radials, 3×5, first radial spinigerous.
Secondary radials, 3×10, hexagonal.
Interradial fields, 5×13, to 14.
Interbrachial fields, 5×7, to 9.

Arms, 5, nearly round, composed of about seven rows of small hexagonal pieces resting midway between the primary radials and supported by a right and left branch of the alternate ray on each side of them severally. Non ciliate. The interbrachial fields support long, pendulous cilia, from five to seven in each field.

Summit, pentagonal, composed of numerous polygonal pieces, some of which form raised folds enclosing fields of smaller pieces. Mouth depressed, sub-central.

Column, round, stout, composed of thin pieces alternately larger and smaller, the larger are the thickest.

The generic name was suggested to us by the resemblance of the summit to a Goniaster.

Goniasteroidocrinus tuberosus, n. sp.

Body, general form subcylindrical, or like a rounded pentagon, a little higher than wide, base deeply excavate. Summit plane or slightly elevated near the centre; the first radials are prolonged downwards and outwards into a spinous process.

Basal pieces five, forming together a regular pentagon; nearly covered by the supra columnar piece.

Subradials five, large, hexagonal, nearly equal in size, joined together, the margin presents four angular, and five plain margins between the

angular notches. The basal, subradial and part of the first radial pieces are seated in the basal pit.

Radials. The first, five in number, are septagonal and spinigerous. The second, five in number, are hexagonal and a little smaller than the first radials. The third radials also five, are septagonal and axillary, their upper oblique margins each supporting three brachials which are hexagonal and reach to the free arms; the brachials are a little smaller than the radials.

Interradial fields. These are five in number, almost identical in size, form, number and arrangement of the hexagonal pieces which compose them. The first rests upon the square end of the subradials, supporting on its upper margin a row of four or five hexagonal pieces gradually diminishing in size from below upwards. The outer oblique margins of the first interradial support each a row of four or five pieces similar to the middle row, these fit into the angular spaces between the middle row of the interradial field and the radials on either side, and reach the arm at the summit of each interradial field.

All the pieces of the calyx rise into a pointed knob near their centres, from which runs a raised fold or rib to the centre of all the surrounding ones. The knobs and ridges of the radials and brachials are more prominent than those of the other pieces: on old specimens the ribs become obliterated and the centre of the pieces more prominent. The basal and subradial pieces have plane surfaces.

Interbrachial fields. These spaces are covered by from seven to nine small pieces, forming together a scutiform console or supporting piece. They stand prominently above the general surface of the body; the lowest is the largest, the others are similar to those forming the arms.

Arms. The arms are five in number, composed of seven or eight rows of small hexagonal pieces. At a short distance from the body the arms branch and terminate in a point, the pieces becoming gradually smaller from the body outward, and the number of rows diminishing. The arms bear no cilia and are always found pendulous. Midway between the arms and attached to the superior margin of the interbrachial fields and depending therefrom, are from five to eight long delicate plumose cilia; they are composed of two or more rows of hexagonal pieces the same size throughout their whole length; they bear delicate pinnules which curve upwards.

Summit, flat or slightly elevated, nearly a regular pentagon, covered by a great number of polygonal pieces which are elevated into rounded knobs. About the centre is a cluster of pieces, (a central piece surrounded by five, six, or seven others,) very much larger than the remainder from which proceed strong, curved ridges meeting at the arms, and enclosing five sunken fields which vary in size and in the number of the pieces forming them. Without and along the margin are five fields, irregular in size and form, consisting of from six to fifteen pieces. The mouth is situated near the centre in the largest field on the summit, and can always be distinguished by the greater number and smallness of the pieces surrounding it, it is round and depressed.

Dimensions.

Diameter on second radials, - - - - -	1·00	inch.
Height from base to arms, - - - - -	·20	"
Length of spines on first radials, - - - -	·20	"
Greatest diameter of summit, - - - -	1·20	"
Least diameter of summit, - - - - -	·80	"
Greatest height of summit, - - - - -	1·00	"
Length of arms of a specimen whose summit diameter is $1\frac{30}{100}$ inch length to bifurcation,	·70	"
Length of longest branch, - - - - -	1·10	"
Length of ciliated branch, - - - - -	1·60	"
Thickness of ciliated branch, - - - - -	·5	"

Geological position and locality. Found in the beds near the top of the knobstone member of the subcarboniferous beds on Clear Creek, Hardin Co., Ky., also in the same geological position in Washington and Montgomery Counties, Indiana. Its vertical range is quite limited. A crinoid (*Acanthocrinus longispina*) closely resembling ours has been found near Coblenz, and at several other Rhenish localities. It was first described by F. A. Roemer in 1850,* and again in 1854 by Zeiler and Wirtgen,† the differences are such that we unhesitatingly refer our fossil to a new genus. The columns are very unlike. Although closely resembling each other in the interradial and anal fields, and the number of radials, yet they differ widely in the arrangement of the brachials as they approach the arms, the interbrachial fields and the summit. Instead of from sixty to eighty arms all similar, our genus has only five larger arms and several smaller fimbriated appendices (arms?) Besides one is from Devonian rocks whilst the other is only found in Sub-Carboniferous strata.

FORBESIOCRINUS, De Koninck and Le Hon.

Forbesiocrinus multibrachiatus, sp. nob.

Body subglobose where the arms are folded inward as is usually the case; from the base to the free arms somewhat discoid, robust, externally covered with minute granules.

Basal pieces, three, similar in form and size, forming by their outer margins apparently the upper joint of the column, slightly thickened opposite the middle of the pieces.

Subradial pieces, five, in good specimens presenting five obtusely angular pieces disconnected from each other, resting apparently upon the supra columnar piece.

Radial pieces, 1*st series*. Generally four in each ray, the first five (resting between the angular points of the subradials), are irregular in size and form, four are irregularly hexagonal, twice as wide as high, the fifth pentagonal and much smaller than either of the others. The second and third radials are obscurely hexagonal, similar in form, differing

* F. A. Roemer, N. Jahrbuch für Min., etc., 1850. p. 679, taf. vi, B.

† Zieler and Wirtgen Verhand. Nat. Hist. Verein der Preus. Rhinelande, &c. Bonn, 1855.

lightly in size: the fourth is axillary, obscurely six-sided, rising into a long angular point; on each of its oblique upper sides supporting three pieces of the secondary radials, which are similar in form and nearly as large as the first radials. The last of these being axillary support on their upper oblique margins each, from four to seven brachial pieces: these last are again axillary, and bear on one side a branch of from twenty-five to thirty pieces, on the other branch which is again divided on the sixth or seventh piece above the first division of the arms, each branch of this last division being composed of about twenty pieces.

Interradial fields, 1*st series.* These fields consist of about fifteen pieces each, the first of which rests upon the upper oblique margin of the first radial of the first series. Usually hexagonal, small, this supports two of the second row, similar in form and size; these last again support three of the third row, of the same form but a little larger; these again a fourth row differing slightly in form and size, which are followed by two superior rows of ten pieces each, of irregular forms, sometimes there is another at the summit of which completes the field.

Interradial fields of the 2nd series, five, composed of pieces similar in form, from six to seven in number, variously arranged, sometimes one surmounted by two similar pieces, these by two others, then a smaller one, or one at the base, with one above the other, these again by two ranges of two, then one, all these forms are occasionally found in the same specimen.

Interradial fields of the 3rd series. Usually ten, composed of from three to five pieces, not regular in form or arrangement, occasionally some of the fields are obscure or absent.

Anal pieces, six. The first is septagonal and rests upon the large subradial; upon it are two pieces, nearly similar in size; in the angle formed by their junction is one irregular shaped piece supporting two quite small quadrangular ones.

The arms are twenty in number, of irregular length, each branch divided into three fingers, making sixty in all: they are free from the third or fourth piece of the third division.

The arrangement of the several series of interradial fields between the branches of the arms produces a very large cup, in proportion to which the rays are quite short. The general form of our species is somewhat like that of *Icthyocrinus lævis*, (Conrad) Hall's figure, New York Geol. Rep., pl. 48, fig. 2. In the arrangement of the rays and the interradial fields in three series, it approaches *Forbesiocrinus Wortheni*, Hall (Iowa, pl. 17, fig. 5), from which it differs widely in the number of anal pieces.

Our specimens are nearly perfect, none of them exhibit the patelloid pieces of *F. Wortheni*, Hall. In several species of this genus which have come under our observation there are no patelloid pieces, in a few of our specimens (the prolongation of the superior pieces near the centre of their breadth overlapping the inferior) some of the prolongations are fractured, specimens of this character have probably led to the remark of Mr. Hall before cited. It is highly probable that this prolongation in the living animal was less calcareous than the remainder of the piece, and owing to this circumstance, was differently mineralized from the mass of the piece. This very difference in the composition of the pieces, supposing that the

prolongation was cartilaginous and the rest of the piece bony, would give flexibility to the body of the calyx and would have been especially useful to our similarly arranged species, whose rays are soldered together by the intercalation of three stories of intermedial and interbrachial fields.

Our figures are drawn the size of nature from the largest perfect specimen that has come under our notice, fragments have been found of larger individuals.

Geological position and locality. Rare in the beds of the subcarboniferous limestone near the top of the knob sandstone, Clear Creek, Hardin county, Ky. Also in the same beds in Washington and Montgomery counties, Ia. Vertical range unknown, it is probable that it is quite limited.

Forbesiocrinus ramulosus, sp. nobis.

Body discoid, rays long, prominent.

Basal pieces, three, of equal size, not projecting beyond the column, in perfect specimens appearing like the upper joint of the column; having an unequal thickness, the thickest part being in the centre of the width of the pieces.

Subradials, five, pentagonal, low, four times as broad as high. *Radial pieces*, the first are about twice as wide as high, obscurely quadrangular or pentagonal, lower margin convex, upper concave in the center, convex on the outer corners; the second and third are similar in size and form; the fourth are pentagonal, similar on their lower margins to the first, second and third, increasing in breadth at the centre where they terminate in an elevated point. The first and second radials join each other, the remainder do not touch at any point.

Secondary radials. The oblique upper margins of the fourth primary radials support each, two branches, varying from four tc six pieces (usually four), to the second bifurcation. In like manner the main divisions of the rays, ten in number, branch to the right and left alternately to the end of the main branches, making generally from 14 to 16 branches. These larger branches are subdivided from three to five times.

Anal pieces, usually from four to six. The first is the largest piece in the circle of subradial pieces, hexagonal; on its upper margin is placed a rectangular parallelogramic piece three times as high as wide, on this rests three or four small pieces one above the other.

Interradial pieces. Between each primary ray there is one, sometimes two, hexagonal pieces. It is not uncommon to find some of the rays without an interradial, in the young they are seldom present.

Interbrachials. Usually one between the main ray and the first divisions, sometimes these pieces are found between the main branches and the second, third and fourth divisions. In well preserved specimens the whole body and arms are covered with minute granules.

Column, round, diminishing from the body downwards, composed of very thin circular pieces, with a still thinner muscular (?) piece, separating them; a good lens is required to see this dividing member between the articulations of the column.

Dimensions of medium sized Adult:

Breadth of basal pieces, - - - - - -	·45 inch.
Height of subradials, - - - - - -	·20 "
Width of " - - - - - - - -	·45 "
Length of first 4 radials, - - - - -	·75 "
Length of arms, - - - - - - - -	3·75 "

This crinoid is referred with some doubt to *Forbesiocrinus* of de Koninck as defined by Jas. Hall, Geol. of Iowa, part 2, p. 630. In technical strictness this is not *Forbesiocrinus*, and will not fall into that genus. This particular section of the crinoidea appears to have been a stumbling block to all palæontologists up to this time. The variety of opinions advanced, and the number of genera erected, to receive analogous forms has not diminished the difficulties pertaining to the subject.

Our species has from four to six anal pieces *and no more*, the generic definition requires ten to twenty-four or more; in our specimen the arms are ten, branching, having no tentaculæ, the generic definition requires forty to sixty. If the branches from the first bifurcation are taken as arms, ours instead of ten as we define it to have, has $10 \times 16 = 160$ arms. These differences should certainly be generic, yet the analogy of form is such that it is proposed to modify and extend the generic formula and admit this and other allied forms.

Geological position and locality. Subcarboniferous limestone, Hardin Co., Ky., and in similar rocks in Indiana.

Actinocrinus. (Miller.)

Actinocrinus cornigerus, sp. nobis.

Body. General form subglobular, conical, below the arms having the form of an inverted cone which is about two-thirds the length of the entire body, the whole surface beautifully ornamented with carina, spines and tubercles.

Basal pieces, three, prominent, nearly equal in size, forming together a large irregular hexagon: each piece has a broad leaf-like expansion raised upon its outer margin, overlapping and partially concealing the sutures formed by their junction with the row of pieces following them. Opening pentaphyllous.

First radials, five, hexagonal, near the centre of each is a prominent tubercle from whence radiate six fasciculi of from two to six ribs each; these extend to the edges of the pieces where they are met by similar ones from the next piece, thus forming a series of triangular markings, the points of the triangles resting near the centre of each three adjacent pieces. The lateral markings surrounding the base are quite prominent and form around it a raised hexagon.

Second radials, five, hexagonal, a little smaller than the first radials and similarly ornamented.

Third radials, five, two of which are hexagonal, the others being pentagonal. The strong rib which proceeding from the centre of the first, and extending over the second radials, bifurcates near the centre of the third, giving off two ribs. From the upper margin of the third

radials rise two radials of the second series: on each of these the rib again bifurcates. Each of these last pieces bear two others; on those nearest each other the rib again bifurcates, each branch of the first bifurcation thus bearing three ribs, which are here joined to the free arms.

Interradial pieces. Generally from three to seven, they are disposed as follows: first, a large hexagonal one succeeded by two nearly equal to it in size, also hexagonal, then follow sometimes two, three or four, differing in form, these again are followed by a number of small hexagonal pieces.

Anal pieces, seven to sixteen; the first of the series is hexagonal, in the same circle with the first radials, equal to them in size and having the same ornament, this piece is followed by two others as in the interradial fields, except that the pieces are generally smaller. Upon these succeed four, sometimes more, which are followed by three regular and a cluster of four petal-like pieces with one to the right of the cluster completing the row. The ornature of all these pieces is the same as on those already mentioned, being quite as prominent on the small as on the large pieces, thereby causing an extraordinary rugosity on the smaller pieces.

Interbrachial pieces. In a line with each ray, interposed between the brachials, are two interbrachials, one immediately above the other.

Vault. The surface of the vault is thickly studded with granular markings except on the anal side. The summit frequently has a long spine, nearly central, from which proceed raised folds projecting toward the arms, terminating at a spine or circularly disposed group of pieces around a central one. A short distance within the circle of the arms, along the centre of the folds, the pieces are generally larger than on the interval between them, the tubercles are also much more prominent on these larger pieces. On the anal side the vault is more convex than on either of the other sides, it is covered by about twenty-five or thirty small polygonal pieces not ornamented like the other pieces composing the vault: near the centre of them is a cluster of nearly smooth pieces, six of them very minute and angular, surrounded by six larger angular pieces, making together a stellate figure of six points both falling into and nearly covering one of the hexagonal spaces composing this part of the vault.

Column, round, near the body composed of pieces alternately larger and smaller. Our species resembles most closely *A. costus*, (McCoy) both in its general form, size, disposition and ornature. The absence of a central proboscis, the difference of the basals, the garniture of the vault and the greater number of the arms, renders it an easy task to distinguish between them.

Geological position and locality. Found in great abundance at the quarries on Beargrass Creek, near Louisville, also at Rock Island, Falls of the Ohio. Very few perfect specimens have been obtained. The vertical range appears to be quite small having been procured only from a thin bed of limestone, seven feet thick, situated between the black slate and hydraulic limestone beds near the top of the Devonian rocks in the neighborhood of Louisville, Ky.

Actinocrinus, sp. nobis.

Body, uniform, symmetrical, enlarging rapidly beneath the arms, vault tumidly conical, centrally surmounted by a strong proboscis nearly as long as the height of the body. Base plain below, slightly excavated for the reception of a large column which is round, composed of alternately thick and thin pieces.

Basal pieces, hexagonal, thick, low, margin and angles rounded, slightly inflated, projecting beyond the column around which it forms a pitaliform border, perforation small, pentagonal.

First radials, hexagonal, much smaller than the basal pieces, on the upper margin of which they rest, prominently marked, transversly, by a long knob a little below the centre of the pieces.

Second radials, very small, subquadrangular, nearly as high as wide, inflated in the same manner as the first radials.

Third radials, much larger than the second, differing in size and form, obscure octagonal, septagonal and hexagonal, some higher than wide, others four times as wide as high: on their oblique upper margins they support a series of two secondary radials each, the second of which are axillary, supporting usually four brachials, three being subquadrangular, about four times as wide as high, the fourth obscurely pentagonal, bearing two long delicate arms composed of a double row of joints; the arms become free from the last brachial. The two postero-lateral rays have an additional arm on those branches joining the anal pieces. This gives each postero-lateral ray five arms, and four to each of the others, making in all twenty-two arms of two fingers each. These fingers are fringed with fine long cilia.

Interradial pieces. The first is large, (inferior in size to the first radials), hexagonal, ascending sides diverging, and resting in a deep angular notch between the first radials and similarly inflated; the oblique upper margins support each a piece of the second row, which differ much in their size and form, one in each field usually hexagonal, the other pentagonal, joined they present an angular notch between their summits in which rests one piece; sometimes another, quite small, is added.

Anal pieces. The first is septagonal, and is the largest piece, composing the circle about the basis; upon this rests three pentagonal, or obscurely hexagonal, pieces of the second range; by the same arrangement are added the third and fourth range, each range being composed of smaller pieces than the preceding one, sometimes a small lanceolate piece surmounts this pyramid completing it to the level of the arms. The first anal piece is marked like the first radials, the others are ornamented by a low, central tubercle.

Vault. The vault is covered by numerous polygonal pieces differing slightly in size, inflated, terminating in a point more or less sharp and round near the center of the pieces.

Proboscis. This like the vault is covered by polygonal pieces which differ remarkably in size, knobbed or spinigerous, the side corresponding to the anal side being covered by oblong pentagonal pieces some of which bear a range of two or three knobs or spines, on the opposite side the pieces are relatively much smaller, and the spines longer.

Dimensions of large Specimen.

Height of calyx, - - - - - - -	·95 inch.
" " vault, - - - - - -	·70 "
" " base, - - - - - - -	·20 "
Length of proboscis (not complete), - -	1·80 "
Height of calyx, vault and proboscis, - - -	3·20 "
Length of arms partly concealed, - - -	3·45 "

Geological position and locality. Imperfect, but recognizable, specimens occur at the quarries near Louisville and Nashville Railroad, Clear Creek, Hardin Co., Ky., associated with *Eretmocrinus magnificus*, &c. For the specimen figured we are indebted to the cabinet of O. A. Corey, Esq., who with praiseworthy liberality, placed at our disposal the whole of his splendid cabinet of crinoidea. *A. grandis* is nearly related to *A. turbinatus*, Hall (Iowa, p. 587, pl. ii, fig. 1), also to *A. longirostis* (Ib., pp. 589, 590), from both of these our species differs in the ornature of the pieces, the number of arms, and so far as may be determined, by the figure and descriptions referred to, by the pieces covering the proboscis and the vault, and the number of pieces composing the anal and interradial fields.

Actinocrinus, Miller.

Sub-Genus, Eretmocrinus, Lyon and Casseday.

It is proposed to erect a sub-genus, *Eretmocrinus*, to receive a class of crinoids having the general arrangement of parts by which actinocrinus is recognized, yet differing so widely from that genus in the structure of the arms, the base, and the general appearance as to be instantly recognized. The structure of the arms differing so remarkably from all known genera, would at once suggest a difference of habit in the animal.

Generic Formula.

Basal pieces,	3, large and extending beyond the calyx.
Radial "	3×5, very small.
Brachial "	3×26.
Interradial "	2×4, one larger and one smaller.
Anal "	6×8.
Interaxillaries,	0.

Proboscidiferous.

Arms, 26, long paddle shaped, deeply grooved on the inner face, fimbriated on both sides of the groove.

The generic name was suggested by the oar-like arms of this splendid crinoid.

Eretmocrinus magnificus, sp. nobis.

The general form of the body is that of a double cone, the point of the inferior cone truncated and one third shorter than the upper one, which is prolonged by a proboscis or oval tube; the whole body rugose and below the arms covered by minute granular markings.

Basal pieces three, large, nearly equal in size, forming together a basis resembling a thick button, the margins projecting a considerable distance beyond the body where it joins to it, deeply concave below, the depression left by the column forming a still deeper concavity, occupying about half the diameter of the whole base, the centre being perforated by a small pentapetalous opening.

First radials five, very minute, quadrangular, thrice as wide as high.

Second radials similar in form and size to the first radials. The third radials are axillary, twice the size of the first, and support on each bevilled edge two pentagonal secondary radials, the last of which are again axillary, giving off two rows of three pieces each to the free arms, except in the postero-lateral rays, where the third secondary radial becomes again axillary and supports on each bevilled edge two rows of three pieces which reach to the free arms; the postero-lateral rays supporting five arms each, the others only four. The brachials are considerably broader than long, and so arranged that the salient angle of one piece fits into the retreating angle formed by the two pieces opposite it. Commencing at the junction of the base with the first radials rises a row of single carinated protuberances, more or less prominent, extending from the base along the middle of the rays and their branches to the free arms distinctly marking the course of the rays.

Interradials usually two, a large hexagonal one followed by a smaller one of similar form.

Anal pieces six, the inferior three are pentagonal, their inferior and lateral margins nearly equal, the lines defining the upper are shorter and produce a sharp angular point at the summit of the pieces: between these angular points of the first range, rest two hexagonal pieces a little inferior in size to the first; upon these last rests a hexagonal piece still less than those of the second range. The surface of the anal and interradial pieces are plain surfaces, except the fine granular markings before described.

Vault. The vault is of an elevated conical form surmounted by a proboscis, the whole being covered by irregular sized pieces, generally hexagonal in form, rising from the margins toward the centre and terminating in a point—in some specimens, the centre of the pieces are marked by two or sometimes three points. It happens that all these forms are found in the same specimen.

Arms. The arms of this splendid crinoid are so unlike anything before described as to merit special attention. They are (on medium sized specimens), about four inches in length. They rise from the calyx in a sub-rotund column about one third of their length, when they flatten and expand towards the top: at the middle of their length they are half an inch wide and about a sixteenth of an inch thick, for a short distance the margins are parallel when they suddenly contract by a graceful curve to about half their greatest width, the sides again becoming parallel for half an inch, when they close by a circular curve which bounds the upper extremity. The insides of the lower parts of these arms are flattened and grooved by a deep semicircular sulculus, the margins of which are lined with very fine, long cilia up to the enlargement of the arms, beyond which they cannot be traced, in fact we suppose

they extend only so far. The body of the arm is composed of a double row of pieces, very small below, increasing in size upward; where the arms are most expanded they number about twenty-four to the inch, in the lowest part from thirty-six to thirty-eight to the inch.

Geological position and locality. Found in vast numbers in the quarries near the Louisville and Nashville Rail Road, Clear Creek, Hardin Co. Kentucky, at numerous localities in Indiana, in beds near the top of the Knob member of the sub-carboniferous rocks. On Clear Creek the horizon of our species is 180 feet below the equivalent of the *Batocrinus* and fish beds of Spurgen Hill, Indiana. The arms, and in the absence of these, the general form, especially the button-like projecting base, distinguish this from *Actinocrinus.*

Dimensions of medium sized specimen.

Height from base to foot of proboscis, - -	1·45 inch.
Height of calyx to free arms, - - - -	·45 "
Diameter at free arms, - - - - - - -	1·7 "
" " base, - - - - - - - -	·50 "
" of " - - - - - - - -	·65 "
Height of base, - - - - - - -	·10 "

Megistocrinus, Owen and Shumard.

Megistocrinus rugosus, sp. nobis.

Body subglobose, truncated; below the truncation concave: from the second radials to the summit it is subcylindrical, thence assuming an unsymetrical, subconoidal form; surmounted by a long proboscis. The pieces of the calyx being ornamented with very prominent angular tubercles, give it an exceedingly rugose appearance, hence its specific name.

Column round, composed of alternate thicker and thinner pieces, the thinner ones being broader than the others.

Articulating surfaces marked by very short striæ confined to the outer margin, canal pentapetalous.

Basal pieces, three, forming together an irregular hexagon, the longest diameter of which is parallel to the anal side. The first facet of the column covers nearly four-fifths of the base: outside of this facet, these edges are finely granulated.

First radials, five, forming together with the first anal piece a circle of very symmetrical hexagonal pieces. Their surfaces are beautifully ornamented with striæ disposed hexagonally and interspersed with granular markings.

Second radials, five, also hexagonal though not so regular in form as the preceding ones. That portion of their surface lying nearest to the first radials is generally ornamented with fine granular markings, whilst the portion joining the third radials is strongly tuberculated, this peculiarity together with the comparatively smooth surfaces of the basal pieces, first and second radials, and the intervening interradials, forms a striking contrast with the rough sides and prominent thorns of the upper surface of our species.

Third radials, five, generally irregularly hexagonal, thick, tuberculated, axillary, and support each two brachials. In three of the rays they are axillary, and support on each facet one or two pieces, from which proceed the free arms, each ray thus supporting four arms. In the two remaining rays they are also axillary and support one or two pieces each, the ray having only one pair of arms, thus making in all sixteen arms. This disposition of the number of arms in a ray is constant and characteristic.

Interradials. These vary in adult specimens from thirteen to fifteen, in younger ones we generally find seven or eight. The first three or four pieces of the interradial fields are hexagonal. Situated between the radials, which they resemble in size, form and ornament, the remaining pieces of these fields become gradually smaller, and are less regular in their form and disposition. All of these as well as the other pieces forming the sides of the calyx are very thick, and ornamented by prominent arm bones, or boss-like projections. They are joined together only at their lower edges, the upper portion of each piece being free and separated from the contiguous one by deep sulculi.

Anal pieces, fifteen to twenty-five, varying with the age of the specimen; presenting much the same character as the interradials just mentioned. The one resting on the base is equal in size to the first radials which it resembles, this is succeeded by three large hexagonal pieces, nearly in a line with the second radials, the remainder are smaller and irregularly disposed.

Interbrachials. Between the brachials, and in a line with the radials, are interbrachial pieces, one large and two smaller pieces. In the second bifurcation, in those rays having four arms, and between the last brachials, there is generally one other interbrachial interposed, sometimes two or three. The arms are sixteen in number running off in two pairs of two, and three sets of four.

Vault. The vault is covered by small polygonal pieces arranged in clusters of seven to ten about a central one, which is usually larger than the surrounding pieces, and usually spinigerous. With the exception of the spines, the vault is devoid of ornament. The pieces are raised in the centre giving this part a varicose appearance. The proboscis is long, subcentral, composed of pieces similar to those of the vault; at or near the base of it is a spine which is nearly central, or somewhat larger than any other spine upon the summit.

Geological position and locality. This magnificent crinoid is found in considerable numbers in rocks of the Devonian period, a few feet beneath the black slate, at the quarries on Bear grass Creek near Louisville, Ky. We have referred this fossil to the genus *megistocrinus*, which it resembles so closely in the number and arrangement of the pieces that such disposition of it will hardly be questioned. It is found in the Devonian rocks of the age of the Hamilton group, associated with *Orthis suborbicularis*, *Atrypa reticularis*, *A. aspera*, *Euomphalus cyclostomus?* &c. This is about the same horizon in which Hall found his *Megistocrinus latus*. A fossil closely allied to this is found in the Devonian rocks of Spain, and described by De Verneuil as *Pradocrinus Baylii*,* a second species *P. Americanus*, is found on the Falls of the Ohio.

* Bulletin de la Geol. Soc. de France, 2d Series, t. vii, p. 137, pl. 2, fig. 11.

CYATHOCRINUS, Miller.

Cyathocrinus multibrachiatus, sp. nobis.

Calyx, vasiform, the pieces thick and tumid, surface ornamented with confluent granulose markings. Column, round, proportionally small.

Basals, five, pentagonal rather large; their under surfaces are scooped out forming a patelloid excavation which is entirely overspread by the column. Their superior margins are prolonged into angles.

Subradials, five, fitting into the retreating angles of the basis, four of them are hexagonal, the fifth, the anal piece, is heptagonal. Of these pieces the two postero-lateral ones are larger than the two antero-lateral one; the anal piece is yet larger and longer than any of the remainder. From the prominent centre of each piece, broad plications, vaguely marked proceed to the margins.

First radials, five, generally pentagonal, their width double their height, ornature same as on the other pieces, their upper edges are bevilled, near the centre of each of these edges is a cicatrix bounded by a strong thick margin, which occupies from one-third to one-half of the width of the piece, these support the remaining radial pieces which vary in different rays from two to seven in number, they are very irregular in size though usually wider than high.

Anal pieces, two, the first is obscurely heptagonal, larger than any of the other pieces of the calyx, succeeded by a small parallelogramic piece which forms the basis of the proboscis.

Vault. The form of the pieces composing the vault is unknown. The proboscis is excentric, occupies about one-third of the whole summit and is composed of small irregular hexagonal pieces whose surfaces are thickly studded with fine granulæ. Its length equals the height of the calyx.

Arms. From the last radial pieces of each ray there extend laterally two strong branches, each of which give off five or six smaller ones, these become subdivided and decrease regularly in size as they proceed from the axillary radials: this arrangement can be perceived only when portions of the arms have been removed, as they interlace and overlap each other. The pieces composing the arms have a parallelogramic form, their places of articulation marked by an elevated rim, surfaces otherwise perfectly smooth. We may readily suppose that at their final development the arms number from one hundred to one hundred and twenty.

Our specimen resembles *Cyathocrinus intermedius* of Hall (Iowa, p. 627, pl. 18, fig. 10), yet the differences are so marked that they will be easily distinguished.

Position and locality. Found in the subcarboniferous beds of Montgomery Co., Indiana, associated with *Forbesiocrinus*, *Platycrinus*, *Goniasteroidocrinus* and other crinoidal remains similar to those of the Keokuck limestone of Iowa.

Cyathocrinus multibrachiatus, var.

The basal, subradial, radial and anal pieces have the same form, relative size and position as in *C. multibrachiatus*. In the specimen figured the surfaces of all the pieces forming the calyx are destitute of any markings, wanting entirely the plications and granular ornature found on the

species above referred to; although this is true of another specimen in our collection, we suppose it owing to the imperfect conservation of those particular specimens rather than a constant characteristic of the variety. The principal differences are in the arms and the proboscis. The pieces composing the proboscis of the variety are arranged in parallel rows instead of alternating with each other as they do in *C. multibrachiatus.* The arms of the variety come off as in the species, namely, the last radial piece which is axillary, supports two rays of arms, but the secondary branches such as noticed in the description of the species continue in most instances throughout their whole length without bifurcations. This arrangement will be easily understood by reference to plate 5,* fig. *b*, 1, 2.

Position and locality. This crinoid occurs in the same beds as its congener described above.

Art. XXX.—*Contributions to Mineralogy;* by Fredk. A. Genth.

1. *Native Iron.*

About four years ago I received for examination a mineral, which was said to be found in the neighborhood of Knoxville, Tennessee, in considerable quantities, and which was believed to be a valuable nickel ore. A qualitative analysis of it, made at that time, proved it to be almost pure iron, and the total absence of carbon, phosphorus and sulphur, and its peculiar appearance, made it very probable that it was *real native iron.* The specimen, which I received was $1\frac{1}{2}\times1\frac{1}{2}$ in size, on one side of it the iron was $\frac{1}{4}$th, on the other $\frac{1}{8}$th of an inch in thickness; on one side it was incrusted by a silicate of iron, magnesia and lime.

The iron itself is of a greyish white color, a hackly fracture, and breaks easily into fragments of an irregular shape, which are crystalline, without, however, showing signs of any distinct planes. It is soft and scratches fluorspar with difficulty. Lustre eminently metalic. Dissolves readily in nitric acid. It was found to contain:

Iron,	99·790
Nickel, with a trace of Cobalt,	·140
Magnesium,	0·022
Calcium,	0·121
Silicium,	0·075
	100·148

About a year after I had examined the mineral from Knoxville, I received the *same* substance from northern Alabama as an alloy of gold, platinum, silver, copper, etc., with the request to advise a plan for the separation of these metals.

I have endeavored to obtain more of this interesting substance from both localities, but the parties, probably not being satisfied

* To be given hereafter.

with the results of my examinations, did not comply with my request, and I hope others may be more successful than I have been.

2. *Native Bismuth.*

A fragment of the beautiful variety of Bismuth from the Peak of the Sorato, in Bolivia, S. A., where it occurs in masses of a broadly laminated structure, the foliæ frequently interlaminated with films of native gold, has been presented to me by Chas. M. Wheatley, Esq., and was found to contain:

Bismuth,	99·914
Tellurium,	0·042
Iron,	*trace*
	99·956

3. *Whitneyite.* Am. Journ. Sci., [2], xxvii, 400.

In his Report on Lake Superior, Washington, 1849, p. 447, Dr. C. T. Jackson makes the following observations. "Aug. 3d, 1848. Crossing over the summit of the cliff and descending a few rods on the slope, we came to a little vein, which was supposed to be antimonial copper ore, but which, by blowpipe analysis, gave only arsenic and copper." This passage having escaped my notice at the time of writing my paper, I have not done Dr. Jackson full justice before. It is very probable that Dr. Jackson had my new species (Whitneyite) in his hands as early as Aug. 3d, 1848, (although he having failed to give an analysis of the same, there is no positive evidence of it). It is certain that he had a mineral, in which by blowpipe tests he found *only* arsenic and copper; but he does not express his opinion about it or its claims as a mineralogical species—and therefore, if he has been aware of the true nature of this interesting mineral, he has done an injustice to himself and science by not publishing his views about it.

So learned an investigator as Dr. Jackson could not have been ignorant that it was Domeyko, who first in 1843, described and analyzed the mineral which bears his name and proved the existence of arsenids of copper in nature which had not been recognized by Faraday, and von Kobell by their analyses of the same mineral in its impure and partly oxydized state of condurrite.

It is by no means certain, however, that the mineral noticed by Dr. Jackson, in 1848, was not the arsenid of nickel and copper noticed in this Journal, [2], xix, 417, by T. S. Hunt, and again on p. 15, this vol., by Prof. Whitney.

4. *Barnhardtite.*

This species, of which Breithaupt under the name of Homichlin gives a great many localities, promised, when first observed, to become a very important copper ore of North Carolina; it

has, however, not been observed since in its *pure state.* The localities Phœnix and Vanderburgh mines, mentioned by Otto Dieffenbach, are extremely doubtful, the specimens, which came to my notice from there, were only tarnished chalcopyrite; the Barnhardt mine has proved to be worthless, and is exhausted, whilst the ores from the Pioneer Mills mine, which I have from time to time obtained, were mostly the mineral mentioned in my paper, Am. Jour. Sci. [2], xix, 18, as containing about 40 p. c. of copper, or mixtures of chalcopyrite and barnhardtite with copperglance, which latter could be easily distinguished with a good magnifier in small veins, running through the whole mass, whilst the barnhardtite, previously examined, was quite homogeneous. The mixtures of copperglance with barnhardtite and chalcopyrite, as well as the barnhardtite itself, are interesting results of a peculiar decomposition of chalcopyrite, in which two equivalents of the latter are in action, and after the oxydation of the sesquisulphid of iron of one equivalent, the subsulphid of copper, thus liberated, combined with the other equivalent of chalcopyrite. This oxydation of the sulphid of iron in copper ores and concentration of the copper, resulting from the same, bears an analogy with the peculiar roasting process at the Austrian copper work at Agordo, where an iron pyrites, containing about 2 p. c. of copper, is roasted in lumps of the size of a fist; the copper concentrates in the centre, forming compounds similar to the above mentioned 40 oz. copper ore, barnhardite and erubesite, whilst the crust is chiefly composed of sesquioxyd of iron.

5. *Gersdorffite.*

I have observed this mineral on a specimen of anglesite from Phœnixville, Pa., on which it forms an incrustation upon partially decomposed galena and zincblende, associated with quartz, chalcopyrite and covelline. The very small crystals are cubes with octahedral planes and, very rarely, those of the pentagonal dodecahedron, the latter frequently indicated by the striation of the cubical planes. B.B. it gave the reactions of sulphur, arsenic and cobalt; a nitric acid solution, however, showed the presence of a larger percentage of nickel than cobalt.

6. *Molybdate of Iron.*

I am indebted to Dr. D. D. Owen for some fragments of this mineral from Nevada City, California, and have made a few experiments with the same, but regret that the rarity of this substance prevented a fuller examination. That which could be scratched off the quartz was not quite pure and contained a trace of limonite. Dilute ammonia acted readily upon it and extracted *all* the molybdic acid, leaving behind the hydrated sesquioxyd of iron of a brown color. The sample examined gave 24·3 p. c.

of sesquioxyd of iron, some of which was *certainly* mechanically mixed with it. Dr. Owen found by his experiments 35 p. c. of sesquioxyd of iron—from which it appears that this substance exists in the mineral in variable quantities. This fact and the other that dilute ammonia extracts the molybdic acid easily and completely, leave very little doubt that the Nevada City mineral is a mechanical mixture of molybdine with limonite, although I will admit that no *positive* opinion can be formed about it, unless larger quantities of the pure mineral are subjected to repeated analyses.

7. *Albite.*

a. In a lot of gold ores from California, which were sent to me for examination, I found a peculiar variety from the metamorphic slates of Calaveras county, consisting of a granular variety of albite, calcite, quartz and a talcose or chloritic mineral, mixed with auriferous pyrites and frequently with visible gold, and worked at Angel's, Major Fritz's, Dr. Hill's and Winter's mines. The albite showed sometimes a sublaminated and somewhat divergent structure, but only, where calcite predominated and could be removed by acid, crystals could be obtained. They were small and indistinct, showed however the common form or twins of the same. The following planes are noticed: *I*, *I'*, 1, 1', *O* and *ii*. I analyzed a specimen of the granular variety, freed from calcite by dilute chlorhydric acid, and found:

		By J. L. Smith's method.
Silicic acid,	68·39	....
Alumina,	19·65	....
Sesquioxyd of iron,	0·41	....
Lime,	0·47	....
Soda,	10·97	10·52
Potash,	*trace*	*trace*
Ignition,	0·21	....
	100·10	

b. A massive greyish white variety of albite, much resembling petrosilex and some kinds of jasper, from the Steele mine, Montgomery county, N. C., has been examined in my laboratory by Mr. J. P. Pöpplein, who found it to contain:

Silicic acid,	60·29
Alumina,	19·66
Sesquioxyd of iron,	4·63
Oxyd of manganese,	*trace*
Magnesia,	0·22
Lime,	1·83
Soda,	9·90
Potash,	1·71
Water,	1·20
	99·45

For the determination of the alkalies, the albite, both from the Steele mine and California, were decomposed by fluohydric acid.

Although the material for this analysis appeared to be quite pure and homogeneous, the already commenced alteration of this mineral is indicated by the low percentage of silicic acid, the presence of water, etc.

It is rarely associated with crystals of albite, but frequently with minute crystals of orthoclase, sphene, ripidolite, gold, pyrites, blende, chalcopyrite and galena.

8. *Ripidolite.*

The most interesting associate of the massive albite from the Steele mine is ripidolite, because it is the result of its alteration, as can be easily observed from the fact that, wherever the albite has a crack, through which water could penetrate more readily, a greenish line makes its appearance, which indicates the commencing change; where this has already made more progrsss, it can be seen that the ripidolite is lining both sides of the fissures, whence it frequently extends through larger masses, which are not rarely completely converted into it, but sometimes contain a nucleus of albite, often having the diminutive shape of the original piece.

In cavities it is rarely observed in wormlike aggregations of microscopic crystals, sometimes in peculiar casts,* having the appearance of crystals, but generally in masses of aggregated scales of a dark olive green color.

* Prof. J. D. Dana, who had the kindness to examine these casts, makes the following remarks in a letter, dated New Haven, June 28, 1859:

"I doubt their being pseudomorphs for the following reasons:

1. The even manner, in which they are often cut through, and the variety of directions, looking as if the cuts were due to crystalline plates that have been removed;

2. The fact that the cuts sometimes go only half way through the pseudo-crystals;

3. The irregularity of form presented; for although the surfaces are flat, there is no symmetry in the arrangement of the planes.

4. The surfaces large and small in nearly all cases are marked with equilateral triangles; while if they were true pseudomorphs, retaining the markings of the original crystal, they would be confined to planes of one kind; that is, if rectangular prisms, they might possibly occur in one pair of the faces, but would not also on the others at the same time, and much less would they be found on the planes replacing the angle. Moreover such regular triangles look as if the system of crystallization was rhombohedral or monometric, while the forms are very far from either.

5. In the largest pseudo-crystal there is a piece of the rock projecting on one side. Now this projecting piece has its margin for a breadth of nearly a line smoothly flattened into the same plane with the face of the crystal,—seeming to show that both the face of the crystal and this flattened surface of the rock were made by pressure against a flat surface of another crystal. Such triangles on all the faces, in connection with the other particulars mentioned, appear to me to show that there must have been originally intersecting crystalline plates with angular cavities between, and that the ripidolite occupies these cavities; if such plates were triangularly marked they would have impressed the triangles alike on all the faces of the ripidolite, filling the cavities. The difficulty in this view of the case is this—that such triangles do not occur on any mineral that I can suggest as the probable cause. They are found on some foliated chlorite, ripidolite, clinochlore and pyrosclerite, but what else?

I confess that I do not fully understand the ripidolite."

I found the pure mineral to contain:

Silicic acid,	24·90	contains	12·93	oxygen	=	1·20
Alumina,	21·77	"	10·17	11·55		1·08
Sesquioxyd of iron,	4·60	"	1·38			
Oxyd of iron,	24·21	"	5·37	10·74		1·
Oxyd of manganese,	1·15	"	0·26			
Magnesia,	12·78	"	5·11			
Water,	10·59	"	9·41			0·87

The oxygen ratio of $RO : R_2O_3 : SiO_3 : HO$ being $1 : 1·08 : 1·20 : 0·87$, the ratio of the equivalents would be $= 12 : 4 : 5 : 10$, and considering alumina and sesquioxyd of iron as replacing silicic acid the formula $= 3\dot{R}_4\left(\begin{smallmatrix}\dddot{Si}\\ \dddot{R}\end{smallmatrix}\right)_3 + 10\dot{H}$, or perhaps better $= \dot{R}_4\left(\begin{smallmatrix}\dddot{Si}\\ \dddot{R}\end{smallmatrix}\right)_3 + 3\dot{H}$.

9. *Pholerite.*

A mineral has been observed in several of the coal mines of Schuylkill county, Pa., under similar circumstances to those, under which pholerite has been found in France and Belgium, that, their physical properties being the same, I consider them identical, notwithstanding the differences between my own and Guillemin's analyses.

At Tamaqua it is found in scales of a yellowish white color, which, however, can be easily removed by dilute chlorhydric acid, and near Pottsville in snow white nacreous scales of a pearly lustre.

Under the microscope the scales appear to be clinorhombic with the planes *iī* predominating and $-1\bar{i}$ indicated by the truncation of the acute basal edge of the right rhomboidal prism.

I have made several analyses of the mineral from Tamaqua, both in its original state and after purifications by dilute chlorhydric acid.

The analyses were made by fusion with carbonate of soda, as well as with concentrated sulphuric acid; the silicic acid separated by the latter method dissolved completely in boiling carbonate of soda. The alkalies were determined by J. Lawrence Smith's method:

	I.	II.	III.	IV.
	Original Mineral.	Extracted by Chlorhydric Acid.		Calculated.
	By $NaO.CO_2$	By $NaO\ CO_2$	By $HO\ SO_3$	$\dddot{Al}_3\ \dddot{Si}_4 + 6\dot{H}$
Silicic acid,	= 46·93	46·98	46·81	47·06
Alumina,	37·90	39·65	39·56	39·20
Sesquioxyd of iron,	0·18	——	——	——
Lime,	0·93	——	——	——
Soda,	Not determined.	0·11	0·11	——
Potash,		0·06	0·06	——
Water,	13·98	13·69	13·91	13·71
	99·92	100·49	100·45	100·00

These analyses show that many of the varieties of the so-called kaolin belong to pholerite.

10. *Scheelite.*

I have observed in North Carolina several new localities of this mineral.

a. At the so-called Dutchmen Vein of the Bangle mine property, Cabarras county, it has been met with between 90 and 100 feet depth, associated with pyrites and chalcopyrite in quartz; forming an ore, which contains from 2 to 3 ounces of fine gold in 2000 pounds. Although it is considerably disseminated through the whole mass of ore in fine grains, the largest masses, which I have seen were not over $\frac{3}{8}$ths of an inch in diameter.

No crystals have been noticed, but only granular masses of a pale yellowish brown color, distinctly showing the octahedral cleavage. It contains:

Binoxyd of tin,	0·13
Tungstic acid,	79·52
Oxyd of copper,	0·08
Sesquioxyd of iron,	0·18
Lime,	19·31
	99·22

b. Another locality is at the Flowe mine, Mecklenburgh county, N. C., where it is associated with barytes, chalybite, pyrites, chalcopyrite, wolfram and rhombic tungstate of lime.

Not more than two crystals have been observed; the first being a modification of the octahedron 1, slightly truncated by 1*i*. It has a yellowish brown color and would, if perfect, have a length of $\frac{3}{16}$ of one inch; the other crystal was about half that size, had a fine orange color and was a combination of the planes $\frac{1}{2}$ and *ii*; it contained a small quantity of *tungstate of baryta*. Both crystals gave B.B. traces of tin.

11. *Rhombic Tungstate of Lime.*

Found also at the Flowe Mine.

It has a yellowish and greyish white color, and a vitreous lustre, which is subadamantine on a fresh fracture.

The crystals are small and indistinct, an aggregation of many individuals frequently formed into one crystal; the largest one, which I have seen, but which was very imperfect, was $\frac{1}{4}$th of an inch long. All crystals contain a nucleus of wolfram. I have noticed the following planes: *I*, $i\breve{i}$, $\frac{1}{2}\breve{i}$, 1 and $1\breve{i}$; cleavage could not be observed.

Are these crystals pseudomorphs? I do not believe it, at any rate, they have not the appearance of pseudomorphs. We know that lime is isomorphous with oxyd of iron and manganese, I would therefore suggest that tungstate of lime is *dimorphous*, and that in this case it is coating a nucleus of $\binom{Fe}{Mn}O, WO_3$, just like a chrome-alum crystal, when placed into a solution of alum,

deposites upon itself a coating of the latter, or in the same manner, in which the green tourmaline, of Chesterfield, Mass., surrounds a nucleus of the red. I do not think that ever anybody considered the green a pseudomorph of the red one?

12. *Wolfram.*

I have examined the wolfram, which forms the nucleus of the rhombic tungstate of lime.

Only one crystal has been observed yet, which shows the planes *I*, *ĭĭ*, ½*ĭ* and 1*ĭ*. Sp. grav. at 25° Cels. =7·496. It contains:

Tungstic acid,	75·79
Oxyd of iron,	19·80
Oxyd of manganese,	5·35
Lime,	0·32
Binoxyd of tin,	trace
	101·26

This corresponds with the formula: $4FeO, WO_3 + MnO, WO_3$.

13. *A few observations on the occurrence of Gold.*

Much has been said and written about the occurrence of gold in veins and elsewhere and the formation of the same, but comparing the different theories with some very important facts, we are often at a loss to explain the latter satisfactorily, and it seems to me that we know but very little about this difficult subject. Without any intention to discuss the merits of the different theories, I will give in the following a few data, which may help to throw some light on this question.

Gold is frequently found in diorite (in smaller quantities in syenite and granite) and although it is only rarely observed in the massive rocks, I have seen specimens from Honduras, C. A., where it was imbedded in the diorite without any other association. The result of the complete decomposition of the diorite is generally a red clayish soil and this has in the gold region of North Carolina, etc., a high reputation for its richness in gold. It was in the diorite region of Cabarrus County, N. C., where the first large piece of gold was found, weighing twenty-eight pounds. All this soil is more or less auriferous, but containing the gold somewhat concentrated, nearly in the same ratio, in which the lighter particles have been washed away. But not only in this country the diorite has been found to be auriferous, as is proved by the large piece of eighty-six pounds which was found at Alexandrowsk near Miask in Siberia, nine feet below the surface, in diorite.

The gold obtained from the disintegrated diorite is generally smooth and rounded as if it was water-worn. This cannot be, however, because it lies still in its original, but only altered matrix, and has not been subjected to any attrition by water and

sand; besides, if we observe any cavities in such gold, we find the sharp edges of crystals, etc., in the same, rounded in a similar manner, just as if the whole piece had been subjected to the action of acids, which in reality seems to have been the case. I believe that this is the most natural explanation, because it tells us at the same time, to what source we must trace the gold, which we find in the veins passing through these formations.

The greatest difficulty presents itself by inquiring into the nature of the solvent. I do not believe it is very probable that the gold has been carried off as a silicate of gold, or by the action of chlorhydric acid upon the sulphid. What seems to me most reasonable, is that it was dissolved as terchlorid of gold. If we remember, that the decomposition of pyrites, one of the most common accessory constituents of diorite, produces sulphuric acid, which in the presence of the never wanting chlorid of sodium and an higher oxyd of manganese may liberate small quantities of chlorine, the most powerful solvent of gold, we have at least a very plausible explanation.

After penetrating the decomposed diorite the solution of gold, passing down the veins, comes in contact with reducing agents and is reprecipitated again, frequently in crystals or crystalline forms. I shall farther below make a few remarks about the substances which precipitate the gold, in veins as well as in beds.

An almost positive proof that the gold in the veins of the diorite formation originates from the adjoining rocks is the fact that the deeper the diorite is decomposed, the deeper the gold is found in the veins. Many of these veins do not contain any gold at fifty feet depth, and I have known veins, which were rich near the surface, not to contain a trace of gold at thirty-five feet depth. Very few of these veins (if not on high hills) carry any gold below 120 feet depth.

The occurrence of gold in beds in the metamorphic slates at great depth can far more be relied upon; Gold Hill, in Rowan Co. N. C., for instance, is over 600 feet deep and the ore as rich as ever. Although it cannot be denied that the greater portion of the gold in such deposits is as old as the stratum itself, in which it occurs, it is certain that inside of such auriferous strata constant changes are going on, gold dissolved and reprecipitated. We could not account for the crystalline structure of most of the gold in such beds if we would not presume that the freshly precipitated gold deposits frequently *upon* that already present.

The description of a few specimens in my collection may be interesting, for they prove that the gold *must* have been in solution.

a. From Whitehall, Spotsylvania Co. Va.,—shows gold associated with tetradymite, limonite and quartz. The gold is crystallized in forms belonging to the rhombohedral system and

showing very distinctly one rhombohedron, scalenohedron and basal plan; it is coating tetradymite and evidently a pseudomorph after it. I have seen other specimens from the same locality, but of inferior value and beauty.

b. The tetradymite from the Tellurium Mine, Fluvanna Co. Va., and the native bismuth from the Peak of the Sorato in Bolivia, S. A., are frequently interlaminated with gold.

I have made some experiments with a solution of terchlorid of gold and tetradymite and found that the latter precipitates the gold from a dilute solution easily with a smooth and brilliant surface.

c. In the upper portion of the ore bed in the metamorphic slates at Springfield, Carroll county, Md., which, near the surface, consists of magnetite and at a greater depth of chalcopyrite and other ores, sometimes films of native gold have been observed coating the cleavage planes of magnetite. On close examination it can be noticed that below the film of gold the magnetite is oxydized into hydrated sesquioxyd of iron.

d. A very striking occurrence of native gold is, that where it is associated with pyrites. Most of the pyritous gold ores are too poor to form a positive opinion about the form, in which they contain the gold, from observation, and many authors are of opinion that the gold may exist in the form of a sulphid, either by itself or as a sulphosalt. If we take it for granted that the pyrites itself is the result of the reduction of iron-salts and bear in mind that protosalts of iron reduce gold *instantaneously*, we cannot adopt this opinion. But even if terchlorid of gold should have been precipitated by sulphydric acid, whilst passing through the vein, it could not remain in that state for a long time, because moist tersulphid of gold in the presence of the smallest trace of an acid is easily decomposed into metallic gold and sulphuric acid. Some specimens of auriferous albite from Winter's vein, Calaveras county, California, show beautifully that, wherever there is a crystal of pyrites, small crystals of gold are attached to it, demonstrating, that the sulphate of iron precipitated the gold, previous to its own reduction into pyrites.

All these facts prove that the gold is carried into the veins from the adjoining rocks, and that the opinion, which considers veins the source of the gold of alluvial and diluvial deposits and the soil, is erroneous.

If another proof was wanted to show the fallacy of this idea, it would be the fact that the gold from the soil or alluvial and diluvial deposits, has rarely the same fineness as that from the veins wrought in the immediate neighborhood of the same, the latter being generally less fine. It is impossible therefore that the destruction of a portion of these veins could have furnished the gold of such deposits.

Philadelphia, July 27, 1859.

ART. XXXI.—*Notice of a Memoir by M. Jules Marcou, entitled "Dyas and Trias or the New Red Sandstone in Europe, North America and India."** (In a letter from Sir RODERICK I. MURCHISON to the Editors.)

Gentlemen—

IN the early part of last winter I read with surprise the following paragraph in a published letter by M. Jules Marcou on American Geology. "I think that the term Permian, at least as given by Murchison for the strata of the government of Perm, a very improper one. There are strong suspicions that Murchison has put into his Permian a part if not the whole of the Trias, and I am almost certain that if geologists accept the Russian Permian as Murchison has defined it as the type, the Trias will disappear from classification in Asia, Africa, America, and Australia."

Considering this to be a serious charge, I wrote to M. Marcou and begged to know the grounds on which he had made it. As he had never been in Russia, I called his notice to another expression in his own letter on American geology in which he says: "not having visited Kansas or Nebraska I have no decided opinion respecting the geology of those countries; for I profess the doctrine that geologists must see with their own eyes," &c. I further expressed a wish, that M. Marcou had acted on his own doctrine, as respected Russia, before he passed so severe a judgment on the researches of M. de Verneuil, Count Keyserling and myself. The replies sent to me by that gentleman, though very polite, being by no means satisfactory, I stated to him my intention of publishing our correspondence in your journal. But I abstained to do so until M. Marcou had produced a fuller explanation of his views.

After a study of the original work of my friends and self, M. Marcou has at length produced his results in the Bibliothèque Universelle de Genève under the title of which a translation is given at the head of this letter.

Leaving my able contemporaries in America and the Geological Surveyors in India to settle their accounts with M. Marcou, I have requested my coadjutor, M. de Verneuil, to answer this article in the French language. In the mean time I confidently refer the judgment of the value of this critical essay to all geologists who have followed the progress of their science.

All such persons know, and particularly those who have read the new edition of my work on Siluria, that the absolute distinction between the fossils of the Permian group or *Dyas* of M. Marcou and those of the Trias is much more sharply defined

* Bibliothèque Universelle de Genève, Mai et Juin, 1859.

than ever, and yet he reverts to the former and obsolete state of the science and merges these two most markedly separated deposits in one natural group. The author applies his new word 'Dyas' to the rocks in question because the two deposits only of Rothe-liegende and Zechstein chiefly prevail in certain tracts; but geologists who have gone through all the proofs I have adduced from various countries of a clear division of the Permian rocks into three parts, of which Zechstein is the centre, will not easily be led to adopt the use of the new word—still less to mix up as proposed the Dyas and Trias in one geological group.

Although I will not answer objections in detail on the geology of Russia which proceed from a writer who has never been in that country, let me inform those of your readers who are in the same condition as M. Marcou, that one of the very reasons he assigns to depreciate the correctness of my ultimate classification, ought to operate in my favor. It is quite true that in most parts of the vast region of Russia (larger than France) occupied by the rocks to which I assigned the name of Permian, there is no large development at their base, of those deposits which in Germany are known as the Roth-todt-liegende, though even in Russia there are tracts in which underlying grits with plants represent that German deposit. But the great fact which I established by visits to all the classical districts of Germany before the publication of the work on Russia and by comparing them with those of Russia is, that whether the pebble-beds and sandstones underlie the Zechstein as in Germany or are intermixed with and chiefly overlie all the limestone as in Russia, the plants of the two regions have been pronounced to be identical. These plants are related generically to the Carboniferous forms, whilst on the authority of Göppert they are pronounced to be entirely distinct from those of the Trias.

In short, the whole geological series does not offer a more complete discordance of type between any two conterminous groups than that which exists between the fossils of the Permian and those of the Trias, whether we refer to their respectively imbedded reptiles, fishes and shells, or to their plants; the one set marking the close of Palæozoic, the others the commencement of the Mesozoic era. Yet these are the two deposits which M. Marcou unites in *one natural group* under the name of New Red Sandstone.

To conclude, let me request you, Messrs. Editors, to have the goodness to translate into English the concluding page of the memoir of M. Marcou, beginning "En resumé," &c., and I will then require no other reason to induce plain geologists to side with my associates and self, by retaining in the great palæozoic division of life, the inhabitants of the Permian era, and by op-

posing the views of an author who considers such fossils to be the remains of "precocious beings"—the 'precursors' or 'advanced guard' of the secondary or Mesozoic populations!"

I remain gentlemen, your very obedient servant,

RODERICK I. MURCHISON.

Geological Survey Office, London, July 25th, 1859.

P. S.—Informing his readers that my eminent friend M. d'Omalius d'Halloy had named the same rocks Penéen ('poor') which I afterwards termed Permian, M. Marcou should recollect, that when I wrote my first letter on the subject to Dr. Fischer at Moscow in 1842, I was far distant from any works of reference. When, however, I consulted the 'Eléments de Géologie' of d'Omalius, published in 1831, I found that although that sound geologist had widely separated his 'Penéen' from the 'Terrain Kuprique,' he still maintained as a part of the group the 'New Red Sandstone,' from which the Permian was specially distinguished. Moreover, I much preferred a purely geographical name taken from a country where fossils abounded, to a term which implied poverty of fossils. In fact, M. d'Omalius tells us (p. 276) that his name Penéen was intended as a French translation of Roht-todt-liegende, the examples of which rock, best known to the Nestor of Belgian geologists, near Malmedy, are indeed quite sterile, as I know from personal examination long before I visited Russia.

The following is the summary of Mr. Marcou, called for in the last paragraph of Sir R. I. Murchison's letter.—EDS.

"To sum up, I am led to regard the New Red Sandstone comprising the Dyas and Trias as a great geologic period, equal in time and space to the Palæozoic epoch, or the Graywackés (Silurian and Devonian), the Carboniferous (the Mountain Limestone and Coal Measures), the Mesozoic (Jurassic and Cretaceous), the Tertiary (Eocene, Miocene and Pliocene), and the recent deposits (Quaternary and later). I also restrict the limits ordinarily ascribed to the Palæozoic and the Mesozoic, and give them proportions more in harmony with those of the Tertiary and recent epoch—to the end that we may have a well balanced and natural classification.

"In the 'New Red' as well as in all other great epochs, we remark that the lower beds (the Roth-liegende) contain Carboniferous forms of life—a kind of '*rear guard*' of the populations whose destruction had commenced, indicating that there were some organisms endowed with a vital force superior to that given generally to other beings, permitting them to witness the disappearance of all their contemporaries, and at the same time to become the spectators—but *isolated spectators*, of the advent of new generations, which, although composed of beings somewhat

similar to their predecessors, are endowed nevertheless with other forms, and of necessity therefore with other habits, associations, and aspects—exactly like the centenary in our human societies. On the other hand, the upper beds of the New Red, such as the 'Halstatter Kalk,' the 'Raibler Schichten,' the 'Bone-bed,' or the Keuper contain forms indicating the approach of another geologic period of secondary beds (Jurassic and Cretaceous), beings which Professor Quenstedt has happily designated as the '*precursors*' or '*advance guard*' of the Mesozoic populations. Precocious beings, these precursors, recalling generally by their sudden appearances and disappearances, those comets which coming from time to time announce that great events are on the point of fulfillment. Or, better still, they may be compared to plants which, forced in hot-houses, flourish in the winter, in place of awaiting the spring and whose pale-tinted flowers, and etiolated or disproportioned forms, appear as if they knew that they were before their time, and as if it was only a species of tentative experiment, which they were performing and so they hastened to disappear to make room for the vigorous and abundant flora of the warm season."—*Bibliothèque Universelle (de Genève)*, Juin 20, 1859, pp. 145, 146.

[*Obs.* It will be interesting for the reader to turn from Mr. Marcou's "rear guards, isolated spectators," and "advance guards," to the plain prose of facts observed by Dr. Newberry in New Mexico, on the site of our author's assumed Jurassic beds. See p. 298.]

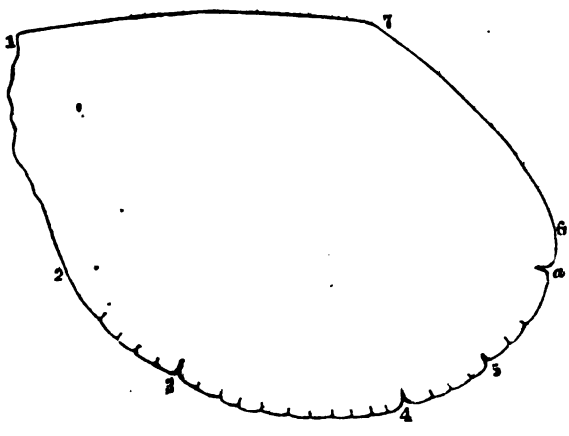
ART. XXXII.—*Examination of a supposed Meteoric Iron, found near Rutherfordton, North Carolina;* by CHARLES UPHAM SHEPARD.

FOR my first knowledge of this Iron, I am indebted to Dr. Thomas S. Duffy of Rutherfordton, who in the winter of 1857 casually mentioned to me at Charleston, that he had been shown a very remarkable specimen of an ore found in his vicinity, of the character of which no one had been able to pronounce a satisfactory judgment. From his description of its lustre and color, and of certain striæ on one or more sides of the mass, I conceived it might prove a large crystal of mispickel. He was kind enough on his return home to send me in a letter, a few grains that had been chipped from the mass. These I found to be slightly malleable and magnetic, while they suffered no sensible alteration before the blowpipe;—properties that at once excited my curiosity, and led to my requesting Dr. Duff to purchase the specimen for me. Sometime elapsed before he was able to effect the object, chiefly owing to the removal of the original proprietor to a distance from Rutherford. In

November, 1858, however, he sent the specimen to me by the hand of Rev. Mr. Bowman; and a month after addressed me the following note, in reply to several interrogations I had propounded. "I have been considering the questions you asked me relative to the nondescript specimen I sent you by Mr. Bowman. It was ploughed up at the foot of a hill near a small water-course, named Sisemore Branch, about half a mile from where it empties into Second Broad River, and four miles from Rutherfordton. It was found by a man named Pinner, who has since removed to the southwest. Search was made, but no similar piece was discovered, although iron ore of good quality was found. There are no iron-works in the neighborhood. This is all the information I am able to communicate about a substance which has puzzled us all here. You will oblige me by retaining it in your possession, till I can say something definite as to its ownership."

My perplexity was greatly increased on the inspection of the mass. Its weight was three pounds and three quarters, and its specific gravity, 6·745. Its shape was imperfectly cylindrical; and it measured a little above three inches in length, by rather less than three in one of its diameters, and two in the other. It was moreover slightly tapering in its figure,—having evidently been broken directly and evenly across at each extremity, from connection with a longer mass, that may have been stalactitic in shape, or even drop-form, like the Charlotte meteoric iron, that was seen to fall August 1, 1835. Almost the first impression created by the fragment is, that it is cast-iron or steel, that has been run in a mould formed by a fossil Calamite, supposing also that the surface was afterwards perfectly cleared of any crust or film, and polished throughout at every point. Singular ver-

1.



tical striæ prevail on one side of the flattened cylinder, while on the other half, a totally different style of marking is visible.

The nearer the view however, the less striking is the resemblance to any species of casting: and the shape is seen to conform but very imperfectly to a section of a Calamite; for, strictly speaking, the mass is only semi-cylindric in figure, three-fifths of the remainder being flat, and the balance but slightly convex.

The first sketch presents an outline of the smaller base.

The same general figure would be afforded by cross-sections made at any point, between the base and summit of the mass; and it may therefore be employed to describe in part, the character of the sides of the cylinder. From 1 to 2 is a pitted, wavy, irregular surface, like that ordinarily seen on true meteorites. Between 2 and 5 is the most perfectly turned and smooth portion of the cylindric surface. Its symmetry is nearly complete, except for four vertical channels or grooves, one-sixteenth of an inch in depth and one-eighth across at top. These have convex sides which meet at bottom so as to touch without actual coalescence,—continuing distinct, though in apposition, for a depth of nearly one-tenth of an inch. In several places also the entire channel of the groove, for the distance of nearly an inch, is filled with the substance of the mineral, as if the matter had flowed into and filled it after the solidification of the sides. It is noticeable also, that the external surface of the matter thus introduced is exactly smoothed off, and pitted, to correspond to the rounded cylindric surface of the mass. These grooves occur at 3, 4, 5 and *a*. Between the grooves are numerous perfectly parallel and equidistant vertical lines, made up of slight punctures or depressions. The punctulated striæ are denoted as to number and position in the figure, by the inwardly projecting points. Other dots are here and there visible also upon the surfaces, intermediate between the punctulated lines, all of which are seen in the second diagram, where a full representation is given of the grooved semi-cylinder itself. Portions of the groove which have been filled up are seen near the bottom. The punctulated lines are denoted on B, C and D. They are less visible on E, while A is undulous and pitted, as in meteorites generally. The side of B, contiguous to A, has a character intermediate, between the broad-pitted and the punctulate.

The opposite side (fig. 3) of the mass is perhaps the most anomalous in its markings. The flat surface F (from which a considerable fragment has been chipped off at *g*) is smooth, with the exception of a multitude of finely pectinated wrinkles, or wave-like elevations, which to the axis, are almost horizontally disposed. These are interrupted in their continuity by several nearly smooth spaces, or channels, running cross-wise from top to bottom, as if produced by the pressure of a broad gravure.

Other lines still more delicate come into view with the aid of a glass, forming a complication of patterns exceedingly delicate,

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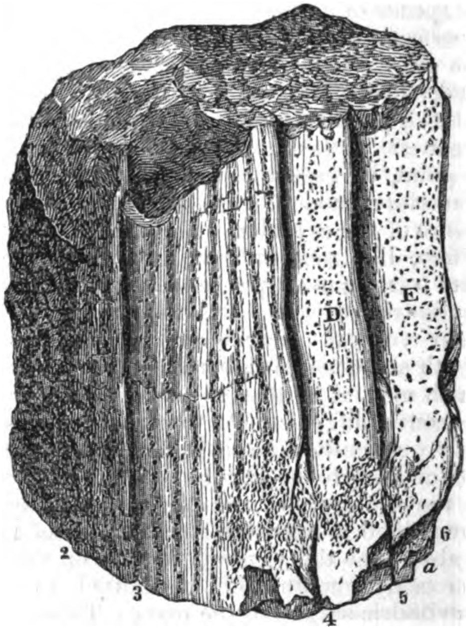

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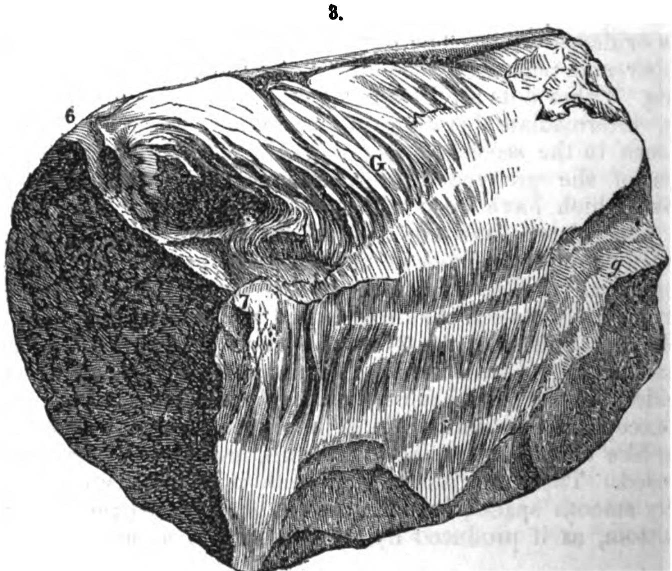


but too intricate for description. They do not however possess any analogy to the etchings on meteoric iron, steel or cast-iron.

The surface G at its uppermost portion (or to the right in the figure) is almost perfectly smooth, presenting only a faint resemblance to the flat side, in the presence of a few nearly obsolete wrinkles. At the middle region, however, these elevations become more strongly marked; while still lower down (to the left) they degenerate in regularity and pass into the pitted and undulous surface, as they form the interior of a crateriform cavity fully half an inch deep, by three quarters of an inch across at its opening. The appearance of this cavity at once suggests the idea that a blunt solid was thrust into the matter when nearly congealed, forcing it into the large wrinkles or waves which form the circumference of the crater. Indeed, it appears highly probable that all the undulations and crimpings, large and small, originated in the foreign body that produced this deep cavity. Very little stress however could be attached to an explanation of such various and unusual appearances as this mass presents, and I could venture upon no conjecture of its origin as a whole, more probable, than that the matter of which it is composed had flowed originally into a cavity in some earthy, refractory material, where it slowly suffered congelation, pressing with greater force perhaps against the walls of the cavity on the striated or semi-cylindric side than upon the other. In any case, it seems quite certain, that its formation occurred with entire exclusion of atmospheric air; and if a meteorite, it must have been protected by a covering of stony matter, until it reached the surface of the earth. The strangeness of external aspect was regarded as affording a certain degree of probability in favor of its meteoric origin; since all who have studied these productions attentively, have recognized in them traits, wholly inexplicable from our knowledge of merely terrestrial matter.

Chemical experiments soon proved that the mass was essentially composed of iron and silicon, with an unusually high proportion of the latter element; a discovery again, that pointed with some significancy towards a meteoric origin, provided the artificial source should also be rendered improbable: for up to this moment, no mineral belonging to our earth has presented silicon combined with any other element than oxygen. I hastened to communicate my result to Dr. Duffy, from whom I received (Jan. 1, 1859) the following additional information. "I had the pleasure of receiving yesterday, your note of the 27th ult. The account you give me of the mineral I sent you is very interesting. I beg you will accept of the mass from me. It was found in the spring of 1855. There is no evidence of iron ever having been made near the place. I shall be able to send you some iron-ore from the same locality, when an opportunity

occurs. The nearest place of iron manufacture is High Shoal (supposed to be twelve miles distant from where the specimen was found). Before I sent it to you, I showed it to several persons connected with this furnace; but they were all equally puzzled to make out what it was. The general conclusion arrived at being, that it was of a mineral character."

As yet I have received no specimens of the iron-ore said to be found at the spot. The geology of the region however is known to be primary, it being fully within the auriferous formation. It is probable that the occurrence of iron-ore at the spot is purely accidental, as such ore is widely distributed throughout the gold region of the southern states.

The supposed meteorite breaks with greater facility than cast-steel, first undergoing a slight condensation, if struck with the edge or the corner of a hammer. The fractured surface is somewhat even, of an iron-grey color, and yields feeble reflections of light in rather broad irregular patches, in shape most resembling those produced on a surface of a coarse-grained dolomite. Besides the broader patches of light from large foliated individuals, are others from frequent scaly points, that are much brighter. The lustre of the exterior is much higher, and the color is lighter also, than that of the fractured surface. Both are nearly identical with those of polished platinum, though the color inclines slightly to that of graphite.

The mass is not wholly without vesicular cavities; but these are very rare, and can scarcely be detected without the aid of a glass. One of them is quite round, with smooth, shining black walls, (probably enfilmed with black oxyd of iron) and another near by, which is elongate and irregular, contains a distinct particle of quartz or silica. It may be mentioned here, that several similar grains, but too minute for detection with the naked eye, were left after the solution of the other constituents of the mass in acids.

It nowhere shows the remains of any coating or crust, and is equally free from evincing the slightest tendency to oxydation or tarnish; and such is the delicacy of the raised lines, punctures and sinuses of the surface, it is impossible to believe that it ever had any such investiture.

The hardness is 7·5 on the mineralogical scale, scratching quartz quite easily, when its sharp angles are applied to rock crystal. A Sheffield cutler pronounced it harder by far, than any steel. He was unable to temper it. When suddenly heated and struck with a hammer, it flew to pieces like glass. A fractured surface was smoothed, and with some difficulty, etched with aqua regia. Its color (unlike to etched steel) was but slightly darkened; and the pattern developed was simply that of a coarse grained saccharoidal limestone, rubbed down to a surface on

sandstone and then moistened. It chips off under blows from the hammer into thin scales, which are easily crushed to powder in a steel mortar. It may then be ground to an impalpable powder in an agate mortar, with greater facility than many earthy minerals of inferior hardness.

The following observations, showing the remarkable passivity of this iron were next made. It is not attackable by dilute sulphuric acid. If previously reduced to powder, a very feeble action is set up, which proceeds with activity as soon as heat is applied. It does not precipitate copper from an acid solution of the cuprous sulphate. In nitric acid also, there is no action, unless the acid is concentrated and slightly warmed, when a few bubbles of binoxyd of nitrogen appear. The surface however does not become sensibly corroded. Hydrochloric acid gives rise to a coating of bubbles only; and if the mass was previously polished, its surface when washed and dried, is found to have grown a shade darker, and to have lost its metallic lustre, attended with the developement of imperfect lines of crystallization.

A few grammes in the state of powder were treated with hydrochloric acid at the temperature of 80°. The extrication of hydrogen gas was gradual, unattended by any sensible production of heat. The action was considerably promoted by slight agitation. On heating to 90°, the decomposition of the hydrochloric acid was much promoted; and the gas was tested, and found to be pure hydrogen.* After some hours, a strong yellowish green solution was obtained; and a film of the same color lined the flask for some distance above the level of the liquid. The flask being left in a state of rest for some time, fell in temperature to 65°; and its contents assumed a partially gelatinized form. On the slightest agitation, its consistency was somewhat dispersed, attended by a singular decrepitation, resembling the ticking of the water-hammer, on the agitation of the fluid in Wollaston's cryophorus. This continued as often as the flask was moved, for many minutes; and was unaccompanied by any sensible extrication of gas. The occurrence of this phenomenon was verified in several repetitions of the solution, and remains at present wholly without an explanation.

One portion of the solution was examined by sulphuretted hydrogen for other metals, without their detection. Another on being cleared of the iron, was found to contain faint traces of magnesium. The main portion of the hydrochloric solution, turbid with the imperfectly suspended silica, was transferred to a filter, upon which the latter was left in a voluminous state, and possessed a dark greyish tinge, as if from the presence of traces

* With strong hydrochloric acid at a lower temperature (say 65°) beautiful green tabular crystals are formed, supposed to be a hydrated double chlorid of iron and silicon.

of carbon (possibly also of silicon). The affusion of hot water produced an instantaneous effervescence, from the extrication of hydrogen. This was continued by subsequent additions, until the acid was almost completely removed, when the hydrated silica occupied the bottom of the filter, having a somewhat lighter shade of white, and on being turned out and broken up, was found to be filled with rounded, amygdaloidal cavities. This singular action of the hot water may proceed from the subversion of a compound present, consisting of the chlorid of silicon and hydrochloric acid, its decomposition being occasioned by the washing out of an excess of hydrochloric acid (aided by heat), —the new bodies eliminated being silicic acid, hydrochloric acid and hydrogen. Thus

$$SiCl, HCl+3HO=SiO^3, 2HCl+2H.$$

Or the effervescence may be occasioned simply by the decomposition of water (aided by heat), through the presence of free silicon.

The silica was so light as to require much care while drying it in a broad platinum capsule; and just prior to its ignition, a bright glow set for an instant through its entire mass, produced by the combustion of a trace of carbon.

The first determination of the proportions of the iron and silicon gave as follows:

Iron, ...	84·00
Silicon, ...	13·57

It occurred to me at this stage of the investigation to determine, whether a compound so rich in silicon would yield a pure chlorid of silicon, if chlorine were presented to it under favorable circumstances. Accordingly, a current of dry chlorine was transmitted over the powdered mineral in a glass tube, the reaction being aided by the heat of an alcoholic lamp. Arrangements were made for condensing the product in a letter U tube, surrounded by a freezing mixture. As soon as the chlorine began to traverse the heated powder, a brilliant red glow attended by scintillations in spots, appeared in the tube for the distance of half an inch (from the end nearest the source of the chlorine); and a dense yellowish smoke was emitted for a moment, from the exit tube. The action in the tube was kept up for several minutes. It now and then burst into an explosive combustion, and dashed an orange red vapor upon the tube, which was afterwards coated red-brown by a crystalline precipitate, and wetted also by a thin liquid that could not be forced to enter the cooling apparatus. At the close of the experiment, a very small quantity of a pale yellow liquid was found in the condensing tube. In this, a few drops of water produced hydrochloric acid and gelatinous silica. A portion of the liquid was also

tested after the precipitation of the silica for iron, unattended by its detection, even in the minutest trace. The volatile product was therefore considered as terchlorid of silicon.

But the charge in the tube which had suffered combustion, was found to be swollen to three times its original bulk; and was for the most part in beautifully perfect hexagonal crystals of a blood-red color, like the minute forms of volcanic hematite. These crystals were found to possess very remarkable properties, a few of which may here be mentioned.

The tube in which they were formed was carefully corked, so as to exclude the air. On allowing a few of them to fall into a dry test-tube, and held in the sun's rays, they turned a deep yellow with a tinge of green, and quickly coiled up and shrivelled,—at the same time, emitting a peculiar ethereal odor.

In the process of sealing hermetically the tube in which the crystals had been formed, a considerable jet of vapor issued from the heated end, and burned with a bright light, attended by a white smoke. As all moisture had not been excluded from the powder, it appeared probable that this combustion was partly to be ascribed to siliciuretted hydrogen; and the smoke was attributed to silicic acid.

The red crystals in the air, out of the sun's rays, deliquesce rapidly, forming a blood-red solution; and are soluble in ether and in water: ammonia throws down from either solution, a mixture of silicic acid and peroxyd of iron.

On heating the contents of the sealed tube to between 250° and 300°, the red crystals are speedily volatilized, and condense as quickly on cooler portions of the tube immediately contiguous,—the precipitated crystals filling the cavity of the tube, and performing the most extraordinary movements, like the gyrations of falling snow-flakes.

When the red crystals are heated in a tube with considerable access of air, they turn yellow, giving rise to a pale yellow vapor. This on cooling, leads to a greyish white coating on the glass, and the formation of a voluminous greyish powder, which on being treated with warm water partly dissolves, leaving silicic acid behind. The solution is precipitated by ammonia, of a bluish green color at first, but afterward turns to red brown. I am therefore led to regard the red crystals, as a compound of sesquichlorid of iron and chlorid of silicon; and suppose that the presence of air (aided by heat) changes it to one, of the protochlorids of iron and chlorid of silicon, with formation of silicic acid,—possibly to a compound of protochlorid of iron and silicic acid only.

The unusual results obtained rendered me desirous of communicating them for correction and advice, to Prof. Wöhler of Göttingen, a chemist who had especially occupied himself not only

with the analysis of meteorites, but with the study of silicon and its more difficult compounds. I accordingly forwarded to him an outline of my results, accompanied by a few grammes of the iron, and solicited his opinion upon the subject. He had the goodness to have an analysis performed for me under his eye, and to engage in some experiments himself upon the material sent.

The analysis afforded the following result:

Iron,	87·10
Silicon,	10·60
Graphite,	0·40
	98·10

Of which he remarks, that without claiming for it the most rigorous exactness, it is sufficiently accurate to show, that the composition of the mass is essentially a compound of $Fe^{6}Si$, or one of

Iron,	88·80
Silicon,	11·20

(Silicic acid being assumed $=Si\ O^{3}$).

He then observes, that it subsequently occurred to him to examine the precipitated peroxyd of iron for phosphoric acid; and that he detected therein, a strongly pronounced proof of its existence. This discovery induced him further to say, that the presence of phosphorus points to its meteoric origin, notwithstanding the absence of nickel in the mass.

I have since made a determination of the phosphorus, and found it to amount to 1·312 p. c.; and combining the numbers of the calculated result upon the iron as being composed of $Fe^{6}\,Si$, and employing therewith Wöhler's determination of the carbon and my own of the phosphorus, the present statement is believed to be a close approximation to the composition of the Rutherfordton mass:

Iron,	87·279
Silicon,	11·008
Phosphorus,	1·312
Carbon,	0·400
Magnesium,	*trace*
	99·999

We recur once more to the question of its origin. It is admitted that it was found in a region containing iron ores, and that the manufacture of this metal had been carried on, though to a very limited extent, at the distance of ten or fifteen miles from the place of its discovery. It is with difficulty supposable that so considerable a mass of a compound before unknown in

chemistry or metallurgy should have originated in such a source. Karsten, the highest authority perhaps upon the products of iron furnaces, says, that the greatest quantity of silicon he ever found in raw iron (pig-metal) was 8·46 p. c.; and that this large proportion occurred under very rare circumstances. Stromeyer who studied the modes of combining iron in silicon with much care, succeeded in uniting them in proportions between 2·25 and 9·3 p. c. of silicon; but in the cases of the higher proportions of silicon, he found the carbon increased also steadily in the compound, to a very high per centage. It would hence appear, that the trifling amount of carbon in the Rutherford mineral, militates against the view of its furnace formation: nor is it probable that it originated in a refinery; for Karsten distinctly asserts, that in that process, the silicon is mostly separated and slagged off. Can it be a natural, terrestrial product, originating after the manner of a fulgurite? Heat enough has perhaps been produced, during the most powerful discharges of lightning to melt a mass of this size; but it remains for us to conceive of the electrolytic action, which should unlose and bring together from any rocks or minerals within our knowledge, such elements as are here found. As bearing upon its meteoric origin, however, we may adduce its peculiarity of shape and structure, the presence of phosphorus, silicon and magnesium,—all of which, as here combined, are eminently meteoric constituents. But as no body has been seen to fall from the skies possessing a similar constitution with the Rutherfordton mass, we are obliged for the present to admit, that the proof of an extra-terrestrial origin remains incomplete; though we may perhaps be allowed to claim, that the evidence already preponderates in this direction.

In a report on meteorites submitted by me to the American Association in 1848, I proposed an order of brittle, metallic meteorites, to provide a place for several examples then regarded by me as meteoric, viz: one from Randolph county North Carolina, another from Bedford county Pennsylvania, together with a third from Otsego county, New York,—this last differing from the first two in important respects as to composition, and which I placed in a section by itself, under the order. The two first mentioned agreed in not containing either of the substances then supposed to be characteristic of true meteors; while that from Otsego, possessed those constituents in the fullest manner. For these reasons, I have thought proper in my later printed catalogues of meteorites, to place the Randolph and Bedford localities among the doubtful meteoric irons, where their number has unexpectedly been augmented by the discovery in Montgomery, Vermont, of a third, possessing the same general properties. I may now add, that the Rutherfordton iron approaches much more nearly to each of the three, than to any other kind of matter with

which I am acquainted. Still I cannot pronounce them identical, though my very imperfect examination had enabled me to indicate silicon from the first, as a constituent of the Randolph specimen. They were each found under circumstances equally favorable as in the case of the Rutherford iron, to the idea of their being natural productions. But unfortunately, the size of the specimens was so small as to render their full elucidation difficult. Nevertheless, I hope very soon to subject them anew to examination; and I think I may add, with every probability of establishing the real existence of the group of meteoric irons originally proposed, but which has temporarily been withdrawn from my classification.

As a convenient name for the Rutherfordton species of matter, I would propose that of *Ferrosilicine*.

ART. XXXIII.—*On a Shooting Meteor, seen to fall at Charleston, South Carolina, on the evening of November* 16*th*, 1857, *with notices of other supposed shooting meteors;* by CHARLES UPHAM SHEPARD.

IN calling attention to the matter of a shooting meteor, I am conscious, that the evidence of its genuineness is not absolutely perfect; nevertheless, it falls so little short of entire satisfactoriness, as to make it fully worthy of notice. No instance of the kind at least, has yet been recorded, entitled to so much confidence. In detailing the circumstances, I shall aim to present every particular, precisely as it came to my knowledge.

Mr. Sparkman R. Scriven, aged about 17, and clerk in the dry goods store of Messrs. Browning & Ketchum of King street, Charleston, a young man of excellent character, was the principal observer of the phenomenon. He had just returned, at half past 8 in the evening of Nov. 16th, 1857, to the residence of his father (Mr. J. M. Scriven) in Morris street, three doors west of King, and having occasion to step into the portico, he saw a red, fiery ball of the size and shape of an orange, slowly descending through a distance apparently of 20 or 30 feet, to the ground. Its fall was scarcely more rapid than that of a soap bubble, giving him time to call his sister, a little girl, to see it strike a high wooden fence, distant about fifty or sixty feet from the portico, and which separated the door-yard from a church enclosure adjoining. It seemed to adhere for an instant to the board against which it struck, and then separated into three parts and disappeared. The evening was dark, it having followed a rainy afternoon, though at the time of the fall, it had ceased to rain and become very foggy.

Nothing further would probably have been heard of the phenomenon but for the accidental reading, by an elder sister the next day at the breakfast table, of a paragraph from the newspaper, relating to a meteoric fall, where the specimens picked up were said to have possessed a strong odor of sulphur. This induced young Scriven, who had never before heard of meteoric falls, at once to examine the fence against which the ball had struck. The fence was eight feet high, and formed of long strips of horizontally disposed boards. It was near the extremity of an uppermost board, that had been detached and bent around so as to present its flat side uppermost, that the body had been seen to impinge. And here it was, that he discovered adhering, a small bristling mass of black fibres. These he detached and carried into the house. As it had rained again during the night, he was led to suppose that the rest of the matter had been washed away. He searched the ground among the dead grass, but not until after the second night, when much more rain had fallen. He could find no more of the same material, though he gathered up numerous small fragments, which proved to be ordinary charcoal.

Mr. Scriven (the father) was so much struck with the appearance of the black fibres, together with the circumstances under which they had been found, that he requested his son to call on Dr. Wm. Pettigrew, the family physician, and describe to him what had happened. Two days however elapsed, before Dr. Pettigrew heard of the case. He immediately repaired to the house, where he was informed of the particulars as above described, and shown a mere pinch of the matter that had been detached from the fence,—the principal portion of it having unfortunately been given to a young man of the neighborhood, an engineer at the depot of the Northwestern railroad, who wished to exhibit it to his friends.

Dr. Pettigrew immediately called to acquaint me of the case; but not finding me at home, we did not meet until the forenoon of the 20th, when he presented me the specimen gathered by Scriven, and took me to the spot.

I heard the statements repeated from the different members of the family, corroborative of those above presented, and examined the place upon the board, from whence the fibres had been gathered. It presented no discoloration or appearance of having been heated or charred, though for many inches on either side, it was slightly blackened in spots. This perhaps was not strange, as heavy rains had fallen since the occurrence; and it might fairly be presumed, that all foreign matter would have been effectually detached. I examined the grass and soil on both sides of the fence, without finding anything beyond little fragments of charcoal, which are common enough in most places about the

premises of houses. We then took pains to find the individual to whom had been given the principal portion of the fibrous matter obtained from the fence; but had the mortification to discover, that having worn it in a paper wrapper for several days in his vest pocket, he had finally mislaid or lost it. Thus little more than a microscopically visible specimen of the shooting star remained for study and examination. Its entire weight is probably less than one-tenth of a grain. When viewed by a single pocket-lens, it seems to be a confused aggregate of short clippings of the finest black hair, varying in length from one-tenth to one-third of an inch. Each portion is straight or only slightly curved. Except in color, they remind one most of that variety of pumice stone from the Sandwich Islands, known as volcanic hair, or as "*Pele's hair.*" They do not seem very prone to break in handling, and appear slightly elastic.

They have been examined under compound microscopes of high power by several persons accustomed to the use of this instrument; but hitherto no one has ventured to suggest a relationship in their properties, to any known form of organic or inorganic matter. The following description is from a note, handed to me by my friend, Dr. F. W. Porcher of Charleston. "Black elongated bodies, perfectly opaque, round and solid; amorphous, not properly smooth, surfaces often furnished with warty dots or projections; rather glossy."

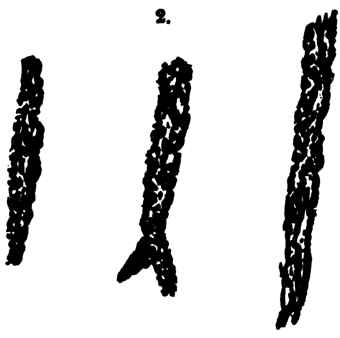
In fig. 1, I have enlarged Dr. Porcher's drawings of a few of the forms about four times, as they presented themselves to him, through a one-third inch object-glass. A few of the bodies are subspinose, and one or two decidedly bifurcate; others are cancellated, and seem capable of separation into smaller fibres. The surfaces are not always perfectly round.

I could spare only a few of them for a chemical trial. These were introduced into a small glass test-tube (previously well dried), and heated by contact of the flame of the blowpipe. They suddenly glowed with a brilliant light, at the same time emitting an odor most nearly resembling the bituminous. A distinct greyish skeleton of each fibre was left adhering to the glass. Barytic water being thrown into the tube was instantly rendered milky, thereby proving the existence of carbonic acid; and the subsequent addition of hydrochloric acid slowly caused the separation of the skeletons from the glass, which led me to infer the presence of silica as a part of the earthy residuum. The little bodies however were not annihilated by the process; but greatly to my surprise were easily seen, by the aid of a single lens, still floating through the clear liquid, preserving in a great measure their original form, with the exception only, of being rendered here and there transparent, as if about one-half of the black

matter had been eaten out and dissolved, leaving the remainder sufficiently connected to maintain the original figure of the body. This honeycomb appearance is also represented in three of the drawings (fig. 2) made by Dr. Porcher.

1.

2.



This is all that I have been able to ascertain concerning the origin, structure, and chemical composition of these singular bodies. They appear to be inorganic, though composed in part of carbon. A large proportion of earthy matter also, enters into their composition.

It will be remembered perhaps, in this connexion, that Berzelius detected what appeared to him to be an organic residuum (resembling burnt hay) in the French meteoric stone of Alais that fell March 15, 1806; and bearing more distinctly still upon our subject, are the highly interesting results recently obtained by Prof. Wöhler on the unknown substance of an organic nature (resinous) in the meteoric stone of Kaba, Hungary, that fell April 15, 1857, and those again arrived at by Prof. E. P. Harris in the Göttingen laboratory concerning the carbonaceous matter in the stone that fell Oct. 13, 1838, at Cape of Good Hope, — a meteorite originally described by Sir John Herschell and Prof. Faraday. Prof. Harris states in his valuable thesis on meteorites (Göttingen, 1859), that he finds a quarter per cent of bituminous matter in the Cape stone, which is soluble both in alcohol and ether, and fusible in a glass tube over a spirit lamp. It finally burns with a bituminous odor and the deposition of carbon.

Is the matter of the Charleston shooting-star analogous to that of the Alais and the Cape meteoric stones? And if so, may the more complete combustion of its carbonaceous ingredient have been prevented by the humid state of the atmosphere at the time of its fall? These are questions that naturally suggest themselves, but to which we are not in a condition to return satisfactory replies at present.*

It is reasonable perhaps to suppose that many aggregates of meteoric matter, such for example as those made up wholly of one or more of the following meteoric elements; carbon, phosphorus and sulphur would, owing to their easy combustibility burn out, even in the upper regions of the atmosphere, and being resolved into gaseous compounds, fail of transmitting to the earth's surface any material proof of their existence. Others again may not be recognized at the surface of the earth, owing to the dispersion of their oxyds in the condition of an impalpable dust, or in solution in water. But however this may be, the facts seem thickening about us of the occasional arrival out of the air, of anomalous earthy bodies, whose descent is unaccompanied by the explosions belonging to the true meteorites, and the precipitated matter is uncharacterized also, by the possession of a thin, well fused coating or crust.

The study of these pseudo or doubtful meteorites, as they have been called, is worthy of a much closer attention than has hitherto been devoted to them; and it is to be regretted, that they continue still to be treated much as the true stones and iron masses were, prior to the time of Chaldni and Howard. Their study seems to be regarded as a field, exterior to the domain of legitimate science,—a region for the reception of all that is vague and contradictory. Much time and labor will no doubt be requisite to disentangle what is really entitled to scientific regard; but this desirable result will be yet longer postponed, if naturalists continue to dismiss as unworthy of investigation, every reported meteoric fall that is unattended with the stereotyped accompaniments, of the descent of the black encrusted stone and iron-mass, the frequency of whose arrival has now so multiplied, as to make the recital of their apparition almost monotonous.

Without here referring to many of the doubtful meteorites, of which I have from time to time given notices, I will venture to call attention to a few other instances, of which no scientific mention has yet been made,—not claiming for them however,

* As having possibly a close connexion with the subject in hand, may be mentioned, two instances recorded in Chladni's list of ancient meteorites. The first of these refers to the fall at Rockhausen near Erfort, July 5, 1582,? during a frightful tempest, of a large quantity of a fibrous substance, similar to hair. The second occurred March 23, 1665? at a place near Lancha, not far from Naumburg, in which case, the matter that fell was likewise fibrous, and resembled a bluish silk. It was also abundant.

any other character than that of mere hints, intended to awaken regard to a fuller investigation of analogous cases, as they may from time to time present themselves.

It was not far from the month of August, 1834, that the newspapers announced the fall of a blazing meteor in the night, in the town of Norwich, Conn. Its descent was unaccompanied by any report, and the mass of matter in its course, came near falling upon the roof of a house, missing it only by the space of about two feet, and nearly burying itself in the rather soft earth of the door-yard. The phenomenon occasioned much fright to the occupants of the house, who were only females. It was seen however, by others. The mass of matter occupying the cavity was of a flattened form, and nearly as large over as a man's head. It had the appearance (in the words of a neighbor who saw it and who described it to me a few weeks after) of a mass of earth, stuck together by the infiltration of tarry matter. And such he took it to be, supposing that some mischievous persons had prepared a fire-ball, and projected it on fire into the air, with the intention of alarming the inmates of the house. I was shown the cavity said to have been produced by the ball; but the specimen had been given to a medical student, who had sent it to his preceptor, residing in or near Albany, N. Y. The circumstances were on the whole so discouraging to the idea of its being a genuine meteorite, that I gave the subject no further consideration. It may not be too late, to recover further information respecting its character.

On the evening of the 23d of April, 1855, at Ochtertyre House, Crieff, in Perthshire (Scotland), a young woman saw from the third story, a shooting star or meteorite, falling with a brilliant light. It struck the gravel walk near to the house. She instantly called two other females, "who saw as it were, a bright object on the gravel, like the sun shining on a large diamond." Two of them ran out of the house and round a court-yard to the spot, taking matches and a candle with them. As soon as they got to the spot, one of them picked up two cindery fragments, which were too hot to hold, and which emitted a strong sulphurous smell. The other felt something hot under her foot, which she also picked up. It had a similar character with the other fragments. At first it was believed that these masses had actually fallen from the heavens; but a closer investigation into their character left little doubt that they were merely fragments of ordinary cinder, derived from a neighboring furnace, situated upon a stream, whence gravel had been obtained for dressing the walks. Being at Sheffield in England, when the subject was undergoing investigation, I was favored by Sir William Keith Murray, at whose residence the occurrence took place, with an inspection of one of the specimens, and was satisfied that a correct general view had been taken of their character. Nevertheless, as

the confidence of the gentleman referred to, was full and entire in the integrity of the witnesses of the phenomenon, it would seem to be an instance, in which the sulphurous matter of a shooting star was not completely consumed before reaching the ground, and that much of the residuum suffered oxydation after it struck upon the cinder of the walk.*

My meteoric cabinet has contained for many years, a few grains of a mixture of carbonaceous and earthy matter in a pulverulent state, sent to me in 1845 by Mr. Black, of Elizabethtown, Essex county, N. Y., (then a member of the Legislature of New York), as having fallen in his wood-yard during the winter of 1844 and 1845.

As an appendix to this unsatisfactory list of supposed meteorites may be added a statement concerning a specimen, the half of which is in my possession, so puzzling in its properties as to leave me in great doubt, whether to arrange it among terrestrial or celestial productions. Its history is briefly as follows. It was brought to Dr. Gibbs of Columbia, S. C., by a poor woman resident in the vicinity, under the impression I believe, of its having fallen from the skies; and as such, was presented to me by Dr. Gibbs. Its size is about that of an ordinary fig, which fruit in a compressed state, it somewhat resembles in figure. Its surface was nearly black, rough and without a glaze. It seemed hollow, and reminded me of an impure, brown iron-stone œtite. On breaking it open, it presented an irregularly shaped cavity, holding nearly a thimble full of silicious sand, and had upon its interior walls, little pellets (half the size of a mustard seed) of pure lead, almost exactly resembling those found in the Hemalga (Chili) meteoric iron.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On Ammonia-Chromium bases.*—Frémy has discovered a class of ammonia-chromium bases, analogous to those formed by cobalt, iridium and rhodium. The author, who appears to be ignorant of what has already been written upon the subject, distinguishes two isomeric modifications of the sesquioxyd of chromium, one of which he terms "chromoxyd" and the other "metachromoxyd," the latter being the soluble and the former the insoluble modification. When metachromoxyd is treated with ammonia in the presence of a salt of ammonium it dissolves completely, forming compounds which are distinguished by their beautiful violet rose red color: alcohol precipitates from these solutions beautiful violet substances, which the author terms amido-chrom compounds, but the analyses of which are not given. These substances are easily decom-

* It was found by Dr. Heddle of Edinburg, that the cinder still retains distinct traces of sulphur.

posed; among the products of their decomposition the author has discovered an ammonia-chromium base which has the formula $Cr_2O_3 . 4NH_3$. The constitution of the salts of this base may be represented by the general expression $Cr_2O_3 . 4NH_3 + 3A$, in which A represents one equivalent of acid. The solutions are almost pure rose-red—the chlorid, which the author considers as a hydrochlorate, has the formula $Co_2O_3 . 4NH_3 + 3HCl$. The salt crystallizes from an acid solution in the form of beautiful regular octahedrons; it forms crystallizable double salts with the chlorids of platinum and mercury. In addition, the author has discovered two other salts, which appear to contain different bases.—*Comptes Rendus*, xlvii, 883.

2. *On the preparation of Alizarin.*—Vilmorin has given a simple method of preparing alizarin from commercial garancin. Garancin is to be treated two or three times with a solution of pure ammonia alum in water, containing half as much alum as the garancin employed. The liquid after filtering has a very beautiful scarlet orange color. It is to be evaporated with repeated stirring, so that the alum may form only small crystals which are encrusted with amorphous alizarin. This product is to be dried, then rubbed to powder, and treated in a water bath with boiling bisulphid of carbon, which dissolves only the alizarin and leaves the alum which may then be employed again. The solution of alizarin in bisulphid of carbon has a brilliant gold yellow color; it is to be filtered and on cooling yields groups of crystalline needles, with a silky lustre. In place of bisulphid of carbon, boiling absolute alcohol may be employed.—*Chemisches Central-Blatt*, No. 24, 1859.

3. *On Wolfram-Steel.*—F. Mayr has prepared an alloy of steel with tungsten which appears to possess very valuable properties. Its tenacity, according to experiments made at the Polytechnic Institute at Vienna, exceeds that of all other varieties of steel hitherto examined, being equal to, on the average, 1159 cwt. to the square inch of section. The method of preparing this steel is not described; the ore of tungsten, as is well known, exists abundantly at Zinnwald in Bohemia and has hitherto found no practical application.—*Chemisches Central Blatt*, No. 25, 1859.

4. *On several new Alcohols.*—Berthelot has shown that cholesterine, Borneo camphor and meconine may be regarded as alcohols, since when subjected to the action of acids, water is eliminated and a class of neutral substances produced analogous to the ethers. The author's method of experimenting consists in enclosing the alcohol and acid together in a sealed tube, and exposing the mixture for eight or ten hours to a temperature of 200°. Under these circumstances combination usually occurs with facility. The compounds of cholesterine with stearic, benzoic, butyric and acetic acids, are solid and crystallizable; more fusible than cholesterine, more or less soluble in ether, very slightly soluble in boiling alcohol. Their physical properties, fusibility, etc., are intermediate between those of the waxes and resins. When treated for a long time with the hydrated alkalies at 100°, these ethers are resolved into cholesterine and acid which remains united with the alkali. The author concludes from his analyses, that the true formula of cholesterine is that of Gerhardt, viz.: $C_{52}H_{44}O_2$. Meconine in combining with acids loses four equivalents of water; the author succeeded in preparing a benzoate and stearate. He farther points out the relations which exist between meco-

nine, $C_{40}H_{10}O_8$, and the products of its oxydation, viz.: opianic and hemipinic acids; $C_{20}H_{10}O_{10}$ and $C_{20}H_{10}O_{12}$. These relations are the same as those between olefiant gas C_4H_4, aldehyd $C_4H_4O_2$, and acetic acid $C_4H_4O_4$.

Orcine, $C_{14}H_8O_4$, also appears to enter into combination with acids, though the quantity of matter at the author's disposal did not permit him to determine this with absolute certainty.

Borneo camphor $C_{20}H_{18}O_2$ plays the part of an alcohol, which the author proposes to call camphol. Camphol combines easily with muriatic acid at the temperature of 100°, and with the organic acids at 200°. The ethers are neutral, colorless, more fusible than camphol, sometimes liquid and sometimes crystallizable. In their formation, two equivalents of water are eliminated. The chlorhydric ether of this alcohol closely resembles the compound formed by the action of muriatic acid gas upon oil of turpentine, and commonly known under the name of artificial camphor, the only difference between them consisting in their power of rotating polarized light. The author did not however succeed in obtaining camphol by heating artificial camphor with an alcoholic solution of soda. Ordinary camphor may be regarded as the aldehyd of camphol, which latter can be obtained from it by boiling with an alcoholic solution of caustic potash. A peculiar acid is at the same time produced which has probably the formula $C_{20}H_{16}O_4$ and which the author calls camphic acid. Camphol is the type of a series of alcohols, represented by the formula $C_{2n}H_{2n-2}O_2$.—*Ann. de Chimie et de Physique*, lvi, 51.

5. *On a new Product of the decomposition of Trinitrophenic Acid.*—By the action of cyanid of potassium upon picric acid, Hlasiwetz has prepared a new acid which he terms isopurpuric acid, and which is isomeric with the purpuric acid obtained from uric acid. Two parts of cyanid of potassium are to be dissolved in four parts of water, the solution warmed to about 60° and the hot solution of one part of picric acid in nine parts of water added with constant stirring. On cooling, the solution becomes a soft mass of crystals, which after purification are brown red and scaly, and reflect a green light. These crystals are the potash salt of the new acid; they are slightly soluble in cold, but perfectly soluble in boiling water. The solution has a very intense and pure purple color. The salt explodes on heating, and gives precipitates with several metallic solutions. The formation of this substance may be expressed by the equation

$$C_{12}H_3N_3O_{14}+3(C_2NH)+2HO=C_{16}H_5N_5O_{12}+C_2O_4+NH_3.$$

The author has analyzed and described various salts of the new acid and has compared its physical and chemical properties with those of purpuric acid. According to Grailich's observations, isopurpurate of ammonia is both crystallographically and optically similar to murexid. In fact, it is difficult to decide from the author's memoir, upon what grounds a distinction is to be made between purpuric and isopurpuric acids.—*Ann. der Chemie und Pharm.*, cx, 289. W. G.

6. *Sir H. Davy's Discovery of the Alkaline Metals: correction of a prevalent historical error in relation thereto.*—It has frequently been a matter of regret that in the history of the world the progress of science has held a secondary place to that of bloodshed, tyranny and political in-

trigue. The most trifling acts of kings and generals are recorded and commented upon, and any misstatement in regard to them is soon detected and pointed out to the confusion of the erring historian. But it is often found to be otherwise in the history of those things which have most benefitted mankind. The most reckless statements in regard to these pass unchallenged as unworthy of notice or rectification, and are disseminated by each succeeding writer until the authority in favor of the error preponderates (numerically at least) over that in favor of the truth.

A striking instance of this occurs in relation to Sir H. Davy's great discovery. Seeing it stated in Lardner's Hand-book of Electricity that it was with the great battery of two thousand pairs of plates belonging to the Royal Institution that Davy succeeded in decomposing the alkalies and resolving them into metals and oxygen, and knowing that such was not the fact, it occurred to me to look up the statements of other physicists upon this point. I was aware that Pouillet in his "Traité de Physique" (from which Lardner has largely copied) makes a similar statement; but this I was prepared to expect in the works of an associate of those savans who alleged to Napoleon that they were prevented from anticipating Davy's discovery only by the want of an apparatus of sufficient power. But that an English philosopher should fall into such a mistake somewhat surprised me, and I was still more astonished to find that British authors, long before the time of Lardner and Pouillet, had given currency to the same misstatement. Indeed so powerful was the array of testimony in favor of this error (at least so far as the *number* of authors went) that I was at one time tempted to doubt my own clear recollection of Davy's own record, and it was only by again turning to it that I could reassure myself. There however he mentions distinctly that the battery used consisted of only one hundred pairs of six inch plates; and still further, in a note to the Bakerian lecture for 1808, he states that many have been deterred from repeating these experiments, supposing that a battery of enormous power is required, and corrects this false impression by stating that one to two hundred pairs of plates in moderate action is amply sufficient. Seeing then that Davy himself deemed this error of sufficient importance to merit correction, perhaps I may be excused for calling attention to the propagation of it by so many respectable authors.

Turner's Chemistry is the earliest work in which I have found this error. In Murray's system (1819) the facts are minutely and correctly stated, but the power of the battery is not given. But what astonished me most was to find that Leithead, Secretary to the London Electrical Society, in a work published in 1837 ("Electricity—its nature, operation and importance," &c.) and dedicated to no less an electrician than Sir M. Faraday, the friend and pupil of Davy, makes the same erroneous statement in his book, page 183.

From Turner and Pouillet the error has spread to a host of minor authors until our scientific literature has become infected with it to a wide extent. Golding Bird, whose means of obtaining correct information were no doubt ample, seems to have labored under the impression that the discovery was made with the great battery; and even de la Rive in

his recent elaborate work on electricity (tome 1, page 46) falls into the same mistake.* Lardner in his Lectures even goes so far as to make an enthusiastic defense of Davy from the imputation that he owed this accession to his reputation to the fortuitous circumstance of his having access to the large battery of the Royal Institution. But he does not correct the error. A few of our minor authors (Bakewell for instance) seem to have read the Bakerian Lecture for themselves; and a few French authors, as Becquerel and Figuier, have nobly given Davy his due.

The extent to which this error has been copied shows with what servility many of our modern compilers of text-books follow the leadership of any great name, and how necessary it is to look to original authorities where accuracy is of the least importance. The facts to which we have called attention occupy no mean place in the history of chemistry, and as it was in Davy's time so it is now, many have been deterred from repeating these interesting experiments by an apprehension that an apparatus of great power is requisite. Such is however by no means the case. Singer states that a battery of fifty pairs of plates in good action are amply sufficient, and of the modern and improved forms a much smaller number is requisite. J. P.

Rochester, N. Y., July 26th, 1859.

[*Note by the Editors.*—Another remarkable example of the regular propagation of error from hand to hand, extending through a large portion of our scientific literature, is the story usually found in text-books, of the accidental discovery in 1790 of the science of galvanism by the twitching of frogs legs prepared for the repast of Madame Galvani. This fabrication is attributable to Alibert, an Italian writer of no repute. Galvani had for eleven years been engaged in an elaborate research on animal electricity, in which he used frogs legs as sensitive electroscopes. The error has been continued from the want of a careful distinction between the real discoveries of Galvani and of Volta. Galvani was an anatomist and physiologist, and he really discovered the existence of electrical currents in living or recently dead animals, and he justly attributed the convulsions of the frogs legs when made without a metallic arc—by contact of the exterior mucous with the interior nervous surface—as due to a nervous or vital fluid, the *true galvanic fluid*. The importance and even the reality of this discovery of Galvani was hidden by the splendors of Volta's pile, until in 1837, more than fifty years afterwards, Matteucci

* The words of M. De la Rive are—"La pile à auges independentes en verre ou en porcelaine avec couples metalliques mobiles, forme sous laquelle fut construite la pile de deux cents couples de l'Institution Royale de Londres, au moyen de laquelle Davy fit les grandes decouvertes qui out immortalisé sou nom." He here evidently alludes to the great battery of the Institution which consisted of two hundred *instruments*, each containing ten "couples" or pairs of plates, thus making 2000 pairs in all. (Davy, Elements of Chemistry, p. 152.) This battery was first used in May or June, 1810 (Phil. Mag., vol. xxxv, page 463), while the alkalies were decomposed October 19th, 1807. (Life of Davy by Paris, and Journal Royal Institution, vol. i, p. 360.) Another battery of 500 pairs of plates was constructed in May, 1808. But the battery used in the decomposition of the alkalies was constructed in 1803 and was very much worn at the time of Davy's discovery. We can find no record of any battery having been constructed for the Royal Institution which answers the description given by M. De la Rive, but if for "couples" we read "instruments" the description applies exactly to the great battery.

revised Galvani's original and correct opinions. Volta's discovery of the pile he announced in March, 1800, to Sir Joseph Banks, although he conceived his "contact theory" in 1796. Galvani died, however, in 1798 (Dec. 4), before the discovery of the pile, and yet we constantly read of the galvanic battery and the frogs legs as related facts of his discovery. It is worse than an anachronism to say that Galvani divided with Volta the honor of discovery of the pile, since he died before it was discovered. Prof. James D. Forbes, in his sketch of the progress of mathematical and physical science in the Encyc. Brit., (8th ed.) has given the best account of the labors of Galvani and Volta to be found in English. In that essay Prof. Forbes says (§ 765) respecting the discoveries of Davy, "Potassium was discovered in the laboratory of the Royal Institution on the 6th of October, (Oct. 19th ?) 1807, and sodium a few days later. The battery used contained 250 pairs of plates of 6 and 4 inches square." Davy in reality employed, it is probable, two batteries; one of *one hundred* pairs of 6 inch plates, and another of *one hundred and fifty* pairs of 4 inch plates.]

7. *On the Electrolysis of Sulphuric acid;* by Dr. ANTON GENTHER. (Liebig and Kopp's Annal., Feb. 1857).—The following experiments were undertaken for the purpose of deciding the question whether an electrolyte of different constitution than the simple binary relation of atom for atom of each element is capable of decomposition by the current. Previous experiments with chromic acid, chlorid of iron and chromate of potash, had well nigh decided the question in the affirmative, but the attempt to decompose sulphuric acid made with eight cells of Bunsen's battery by Prof. Magnus, failed to confirm this view of it. The failure Dr. Genther attributed to the limited force of the current, and accordingly renewed the experiment with fourteen of Bunsen's cells. The anhydrous acid still resisted, and even when the platina poles were approached so close as to ensure the direct transmission of the current, it only gave signs of a rapid bubbling movement. The anhydrous acid was next mixed with different quantities of acid of the constitution SO_3+HO, and the mixture exposed to the action of the same battery in a U-form tube. The proportions first tried were four of the anhydrous to one part of the other acid. This mixture yields a solution crystallizing at 68° F. It is therefore necessary to apply a higher temperature which is invariably obtained by the continued action of the current. The conducting power of this solution is so low as to allow only a very small distance to intervene between the poles. Soon after the action commences oxygen is liberated at the positive pole, whilst not a gas bubble appears at the negative. The solution however being of a brownish yellow cast, becomes colorless in the arm of the tube containing the positive electrode, the color being entirely confined to the other arm. The action being allowed to continue, blue streaks slowly make their appearance on the surface of the liquid at the negative pole, which although multiplied with the duration of the current, are yet very sparingly developed.

In a second mixture the proportions were three parts of the anhydrous acid to one of the acid SO_3+HO. This gives a solution of better con-

ducting power. As in the former experiment oxygen appears at the + pole, but much more copiously; and at the − pole a slight escape of gas bubbles is perceptible, whilst the blue streaks present themselves in greater quantity, coloring the liquid contained in the negative arm of the tube. The odor of sulphurous acid is also distinctly perceptible. With the continuance of the action the temperature rapidly rises, the escape of gas at the − pole is more abundant, sulphurous acid is formed, but the blue streaks diminish when the tube is immersed in water gradually heated, the blue streaks disappear altogether at 140° F., and a more copious formation of sulphurous acid sets in. As the tube containing the electrolyte is gradually cooled the color reappears.

This whole process is effected much more rapidly when the mixture is in the proportion of two parts of the anhydrous to one of SO_3+HO, or of equal parts of both, the temperature being kept at 32° F. The blue color at the − pole clearly proves that sulphur is liberated there, the solution resembling that obtained by dissolving sulphur in anhydrous sulphuric acid. Of this fact, the temperature at which decomposition takes place, and the formation of SO_2, furnish sufficient testimony independent of the color produced.

The development of sulphurous acid seems to be occasioned by the rise of temperature produced in the solution by the action of the current. Nor is it confined to the negative arm of the tube; circumstances which indicate that it is a secondary product.

In regard to the sulphur which has been observed as the negative pole, there are only two ways of accounting for its presence. It is either the result of direct decomposition by the current, or of the reducing action of the liberated hydrogen.

The combination SO_3 with HO, according to Faraday, is decomposed into sulphur and hydrogen at one electrode and oxygen at the other. The same combination subjected to the action of the battery by Genther gave at first only H and O at their proper poles; sulphur was liberated only when the temperature of the electrolyte was considerably raised by the action of the current. When the tube was placed in water kept at 32° F., the liberation of oxygen and hydrogen was of longer duration before free sulphur appeared. The temperature of the electrolyte was found to rise almost instantaneously with the removal of the tube from the water. This would seem to indicate that by keeping the electrolyte at 32°, the liberation of sulphur would be prevented, which shows the great influence temperature has on the product of the decomposition. It was further observed that the odor of sulphurous acid accompanied the liberation of sulphur, owing probably to the action of S on the warm sulphuric acid. If we assume that in this process the liberation of the sulphur is due to the reducing action of H, then it consistently follows, that the H endowed with so strong an affinity, must unite with the sulphur it meets at the moment of separation, and form sulphuretted hydrogen. Not a trace of this gas has however been yet detected. Furthermore if the hydrogen could exert this reducing action, it would at most be but the reducing of SO_3 to SO_2. With such proofs drawn from experiment we must assume the direct decomposition by the current of sulphuric acid into S, which appears at the − pole, and oxygen at the + pole. It

depends on the concentration of the acid whether the extra decomposition of water accompanies the foregoing products.

That an electrolyte differing from the simply binary constitution is capable of direct decomposition by the current is thus shown in the case of SO_3, and even with less room for doubt in the case of anhydrous chromic acid, and chromate of potash, as the researches of Prof. Magnus prove.

II. GEOLOGY.

1. *Teeth and Bones of Elephas primogenius, lately found near the western fork of White River, in Monroe County, Indiana;* communicated by Prof. T. A. Wylie.—On Friday, July 23d, in company with Prof. Cole, I visited the place where these bones were found. It is situated on the farm of Jefferson Wampler, about a mile southeast of the town of Gosport. On the 6th of June last, one of the young men, in whose possession the bones now are, found one of the teeth, which had been washed out from the bank by a heavy rain. This led to a further exploration, and the discovery of the tusks and teeth and several fragments of the skeleton. The bank into which they dug is a stiff plastic bluish clay. The bones were found at the depth of eight or nine feet, in a bed of sand underlying the clay, all in confusion as if they had drifted there, and had afterward been covered with the clay. The sand probably rests on sandstone (Carboniferous) which forms the bottom of the brook not many yards distant. Several of the larger bones were so far decayed that they crumbled on attempting to take them out.

The tusks are much broken and require to be bound with cord to keep the pieces together. Some portions of the ivory are so soft that they yield to the knife like chalk. Toward the point of one of the tusks the substance is much harder. The intelligent young men, W. M. Craven and J. H. Richardson, by whom the discovery of these remains was made, deserve credit for the care they have taken in disinterring and preserving them.

The bones consist of two tusks, four molar teeth, and several fragments, viz., a piece of a rib, an end of the radius (?) much worn, measuring about seven inches across its concave surface, and a few spongy portions of the larger bones.

One of the tusks measures on the outside of the curvature eight feet, a foot or more has been lost from the root, the cavity of which is filled with sand. The diameter of the root end is eight inches, the tusk varies very little in the size of the cross section till near the point. The projection of the axis of the tusk on a plane is nearly a semicircle of a radius of 30 inches. The deviation of the axis from the plane is but slight, though this could not be determined accurately on account of the transverse cracks. The other tusk has lost a portion of the pointed extremity, judging from the appearance of the fracture, this might have been lost before the death of the animal. It measures five feet in length, and in diameter is the same as the other. The weight of the larger tusk is 166 pounds.

There are four molar teeth, two larger and two smaller. The largest measures, in the longer diagonal from crown to base, eleven inches; ver-

tically, eight inches. Across the grinding surface, four inches. The smaller molars are about eight inches, and five inches in the same directions. The length of the grinding surface on one of the smaller molars is six inches. The grinding surfaces of these teeth are nearly flat. The plates of enamel very perfectly preserved. In the larger of the teeth twenty of these double plates were counted; in the smaller, fourteen. The distance between the plates, and the interval between the pairs, is about one-fourth of an inch. They resemble some drawings I have seen of modern elephant's teeth, though the *flattened cylinders* of enamel in the case of the fossil are much more compressed and closer together than those of the recent teeth. The columnar structure, if it might be so called, was very evident in all, particularly in the smaller, where the cylindrical columns of enamel were distinct, and where also the gradual coalescing of three of these into one, could be distinctly perceived.

Indiana State University, Bloomington, August 1st, 1859.

2. *Eruption of Mauna Loa, Sandwich Islands;* (latest information in a letter to J. D. DANA from Prof. R. C. HASKELL, Oahu College, dated Kona, Hawaii, June 22d, 1859).—I have just returned from a second visit to the scene of the lava-flood on Mauna Loa. There is one fact which I observed, that I desire to communicate to you. The real source of the flow is about four miles above the two craters, which in February seemed to be the source. From this point down to the two craters, a crack in the mountain can be traced nearly all the way. At first it is no more than two inches in width, but gradually increases to about two feet. At the present time heat can be perceived in the crack within a few feet of the highest point. But little lava has issued from this crack above the two craters. During the first quarter of a mile, lava has oozed out in different places a few rods apart, to the amount of three or four cubic feet. Below this point there is a stream, now cold of course, a few rods in width. In this flow therefore there is no doubt that there is a continuous crack in the side of the mountain for four miles. How much farther this crack extends down the mountain cannot be ascertained, now at least, for the craters are still sending forth immense columns of sulphurous vapors, and the stream of lava is still flowing below them. This stream however is much smaller than it was in February, and is entirely subterranean for the first twenty-five or thirty miles, except that there are a few holes where the running lava can be seen. In some instances this stream is as much as forty feet below the surface. During this trip I went to the top of Mauna Loa. There is no perceptible action in the crater of Mokuaweoweo. The source of the present flow is probably about 11,000 feet above the level of the sea.

3. *Observations on the Ossiferous Caves near Palermo;* by Dr. FALCONER, (Proc. Geol. Soc. London, Athenæum, July 16, 1859, p. 86).—Dr. Falconer, in the first place, adverted to his previous communication, read on the 4th of May last, before his collections had arrived in England. In the present paper he submitted, with more detailed explanations, the materials on which his first statements were founded. Dr. Falconer then described the physical geography of that portion of the northern coast of Sicily in which the ossiferous caves abound, namely, between Termini on the east, and Trapani on the west. Along the Bay of Palermo, and

again at Carini, the hippurite limestone presents inland vertical cliffs, from the base of which stretch slightly inclined plains of pliocene deposits, usually about one and a half miles broad, towards the sea. The majority of fossil shells in these tertiary beds belong to recent species. At the base of those inland cliffs, but sometimes 50 feet above the level of the plain, and upwards of 200 feet above the sea, the ossiferous caves occur. One of the best known of these is the Grotto di Santo Ciro, in the Monte Griffone, about two miles from Palermo. This cave has been often described. Like many others it contains a thick mass of bone-breccia on its floor, extending also beyond its mouth and overlying the pliocene beds outside, where great blocks of limestone are mixed with the superficial soil. The bones from this cave had long been known, and were formerly thought to be those of giants. Some years since bones were here excavated for exportation; and M. Christol at Marseilles was surprised to recognize the vast majority of remains of two species of *Hippopotami* amongst bones brought there, and counted about 300 astragali. Besides the *Hippopotamus*, remains of *Elephas* also occur. Prof. Ferrara suggested that the latter were due to Carthaginian elephants, and the former to the animals imported by the Saracens for sport.

The government of Palermo having ordered a correct survey of this cave and its contents, it was found that beneath the bone-breccia was a marine bed with shells, and continuous with the external tertiary deposits. The wall of the cave to the height of eight feet from the floor had been thickly bored by *Pholades;* for the space of ten feet higher the side was smooth; and still higher up it was cancellar or eroded. Above the breccia were blocks of limestone, covered by earthy soil, in which bones of *Hippopotami*, with a few of those of *Bos* and *Cervus*, light and fragile, not fossilized as in the breccia, occurred plentifully. In his late visit to the San Ciro Cave, Dr. Falconer collected (besides the *Hippopotamus*) remains of *Elephas antipuus*, *Bos*, *Cervus*, *Sus*, *Ursus*, *Canis*, and a large *Felis*, some of which indicated a pliocene age.

Another cave, the Grotto di Maccagnone, about twenty-four miles to the west of Palermo, was lately the especial subject of the author's research, whose attention was directed to it by J. Morrison, Esq. In its form it differs from that of San Ciro, being much wider. Its sides show no Pholad markings nor polished surfaces, as far as they are yet bared. It has a reddish or ochreous stalagmitic crust covering the interior. It agrees with the San Ciro Cave in its situation at nearly the same elevation above the sea and above the tertiary plain; and in its enormous mass of bone-breccia and great accumulation of limestone boulders covered by the humantile soil with loose bones. The floor had already been dug over for bones. Beneath this (as shown by the section which Dr. Falconer made at the mouth of the cave) was the usual ochreous loamy earth (called "cave earth"), with huge blocks of blue limestone, which impeded the operations of search. Then a reddish-grey, mottled, spongy loam, cemented by stalagmite, occurring in thick patches, and called "cinere impastate" by the peasants. This covers bone-breccia resembling that of San Ciro, and, like it, is full of bones of *Hippopotami*. The remains of a large *Felis*, two extinct species of deer, and of *Elephas antiquus* were met with also. The last is characteristic of the other pliocene caves of

Europe. Coprolites of a large *Hyæna* occur in ochreous loam; and especially in a recess on the face of the cliff near the cave's mouth. A patch of the "cinere impastate" was found under the superficial earthy floor of the cave at one spot near the inner wall.

The author next described some remarkable conditions in the roof of the cave. About half way in from the mouth, and at ten feet above the floor, a large mass of breccia was observed, denuded partly of the stalagmitic covering, and composed of a reddish-grey argillaceous matrix, cemented by a calcareous paste, containing fragments of limestone, entire land shells of large size finely preserved, splinters of bone, teeth of ruminants and of the genus *Equus*, together with comminuted fragments of shells, bits of carbon, specks of argillaceous matter resembling burnt clay, together with fragments of shaped silicious objects of different tints, varying from the milky or smoky color of chalcedony to that of jaspery hornstone. This brecciated matrix was firmly cemented to the roof, and for the most part covered over with a coat of stalagmite. In the S. S. E. expansion of the cavern near the smaller aperture, a considerable quantity of coprolites of *Hyæna* was found similarly situated in an ochreous calcareous matrix, adhering to the roof, mingled with some bits of carbon, but without shells or bone-splinters. On the back part of the cavern, where the roof shelves towards the floor, thick masses of reddish calcareous matrix were found attached to the roof, and completely covered over by a crust of ochreous stalagmite. It contained numerous fragments of the siliceous objects, mixed with bone-splinters and bits of carbon. In fact, all round the cavern, wherever the stalagmitic crust on the roof was broken through, more or less the same appearances were presented. In some parts the matrix closely resembled the characters of the "cinere impastate," with a large admixture of calcareous paste. With regard to the fragments of the siliceous objects, the great majority of them present definite forms, namely, long, narrow, and thin; having invariably a smooth conchoidal surface below, and above, a longitudinal ridge bevelled off right and left, or a concave facet replacing the ridge; in the latter case presenting three facets on the upper side. The author is of opinion that they closely resemble, in every detail of form, obsidian knives from Mexico, and flint knives from Stonehenge, Arabia, and elsewhere, and that they appear to have been formed by the dislamination, as films, of the long angles of prismatic blocks of stone. These fragments occur intimately intermixed with the bone-splinters, shells, &c., in the roof-breccia, in very considerable abundance; amorphous fragments of flint are comparatively rare, and no pebbles or blocks occur either within or without the cave. But similar reddish flint or chert is found in the hippurite limestone near Termini.

In regard to the theory of the various conditions observed in the Maccagnone Cave, the author considers that it has undergone several changes of level, and that the accumulation of bone-breccia below and outside is referrable to a period when the cave was scarcely above the level of the sea. Dr. Falconer points out the significance of the fact, that although coprolites of *Hyænæ* were so abundant against the roof and outside, none, or but very few, of the bones of Hyænas were observed in the interior. He remarked also on the absence of the remains of small mammalia,

such as Rodents. He inferred that the cave, in its present form, and with its present floor, had not been tenanted by these animals. The vast number of *Hippopotami* implied that the physical condition of the country must have been very different at no very distant geological period from what obtains now. He considered that all deposits *above* the bone-breccia had been accumulated up to the roof by materials washed in from above, through numerous crevices of flues in the limestone, and that the uppermost layer, consisting of the breccia of shells, bone-splinters, siliceous objects, burnt clay, bits of charcoal, and coprolites of *Hyæna*, had been cemented to the roof by stalagmitic infiltration. The entire condition of the large fragile *Helices* proved that the effect had been produced by the tranquil agency of water, as distinct from any tumultuous action. There was nothing to indicate that the different objects in the *roof-breccia* were other than of contemporaneous origin. Subsequently a great physical alteration in the contour, altering the flow of superficial water, and of the subterranean springs, changed all the conditions previously existing, and emptied out the whole of the loose incoherent contents, leaving only the portions agglutinated to the roof. The wreck of these ejecta was visible in the patches of "cinere impastate," containing fossil bones below the mouth of the cavern. That a long period must have operated in the extinction of the Hyæna, Cave-lion, and other fossil species is certain; but no index remains for its measurement.

The author would call the careful attention of cautious geologists to the inferences,—that the Maccagnone Cave was filled up to the roof within the human period, so that a thick layer of bone-splinters, teeth, land-shells, coprolites of *Hyæna*, and human objects was agglutinated to the roof by the infiltration of water holding lime in solution; that subsequently, and within the human period, such a great amount of change took place in the physical configuration of the district as to have caused the cave to be washed out and emptied of its contents, excepting the floor-breccia, and the patches of material cemented to the roof and since coated with additional stalagmite.

4. *On the Bone cave in Devonshire;* by Mr. PRESTWICH, (Ibid.).—Mr. Prestwich gave in a few words the results of the examination of the bone cave at Brixham in Devonshire. The cave has been traced along three long galleries meeting or intersecting one another at right angles. Numerous bones of *Rhinoceros tichorhinus*, *Bos*, *Equus*, *Cervus tarandus*, *Ursus spelæus*, and *Hyæna* have been found; and several flint-implements have been met with in the cave-earth and gravel beneath. One in particular was met with immediately beneath a fine antler of a Reindeer and a bone of the Cave-bear, which were imbedded in the superficial stalagmite in the middle of the cave.

5. *Observations on a Flint-implement recently discovered in a bed of Gravel at St.-Acheul, near Amiens;* by JOHN WICKHAM FLOWER, Esq., (Ibid.)—The gravel capping a slight elevation of the chalk at St.-Acheul is composed of water-worn chalk-flints, and is about ten feet thick; above it is a thin band of sand, surmounted by sandy beds (3 feet 6 in.), and brick-earth (11 feet 9 in.). In this gravel the remains of elephant, horse, and deer have been found, with land and fresh-water shells of recent species. From the gravel Mr. Flower dug out a flint-implement,

shaped like a spear-head, at about eighteen inches from the face of the pit, and sixteen from the surface of the ground. Mr. Flower in this communication pointed out evidences to prove that this and many other similar flint-implements obtained from the same gravel were really the result of human manufacture, at a time previous to the deposition of the gravel in its present place. Mr. Fowler's visit to St.-Acheul was made in company with Messrs. Prestwich, Godwin Austen, and Mylne, with a view to verify the discoveries made respecting the occurrence of flint-implements in the gravel and peat of the Somme Valley by M. Boucher de Perthes, of Amiens.

6. *On Professor C. Piazzi Smyth's supposed proofs of the Submarine Origin of Teneriffe and other Volcanic Cones in the Canaries;* by Sir C. LYELL, F.R.S., D.C.L., etc., (Phil. Mag., July, 1859.)—Since the publication in the Philosophical Transactions of my paper on the Lavas of Mount Etna,* a Report by Prof. Smyth, Her Majesty's Astronomer for Scotland, has been printed by the Admiralty of Great Britain, "On the Teneriffe Astronomical Experiment of 1856," in which a chapter on geology and "volcanic theories" is introduced.

This chapter, which did not form part of the original report as published by the Royal Society in the Philosophical Transactions for 1858, contains a discussion of Von Buch's theory of craters of elevation, together with critical remarks on passages in my writings, and those of Mr. Poulett Scrope. I do not feel myself called upon to reply to any of these comments, as they relate to subjects to which the astronomer for Scotland cannot be expected to have devoted much time or attention; but when facts are cited, respecting Teneriffe and other islands of the Canariad Archipelago, supposed to be conclusive on a controverted question of high theoretical interest, and in a work brought out under the sanction of the Admiralty, I think it right to point out the mistakes into which the author has fallen, and the insufficiency of the evidence on which he relies.

At p. 553 of the new edition of the report above alluded to (dated February, 1859), the following passage occurs:—

"The question of the submarine origin of Teneriffe no longer depends only on the general structure of its lava-beds, or on analogies from the fossiliferous strata of the adjacent islands of Grand Canary and Palma, but has now the additional and most unanswerable argument of fossil shells having lately been discovered about the slopes of the crater."

And again in the same page:—

"The proof of fossil shells, so long demanded, has now been supplied; and with them must be accepted the fact of the slopes on which they rest having been once submarine, though now subaerial. The great crater, then, having incontestably suffered elevation, was that elevation necessarily connected with its present form and character?" &c.

When I first read these passages, I naturally concluded that some new discovery had been made of marine fossils *on the slopes* of the great outer cone of Teneriffe, or "crater," as it is termed in the report above cited; but having never seen or heard of such a fact myself when in the island,

* On the Structure of Lavas which have consolidated on steep slopes; with Remarks on the Mode of origin of Mount Etna, and on the Theory of Craters of Elevation, by Sir Charles Lyell, Phil. Trans. part 2, 1858, p. 703.

I wrote to Prof. Smyth to know where and at what height above the sea, and under what geological circumstances, he or his informants had detected these shells. In reply he could give me no information on any one of these three heads, "he had merely given the statement on report, and not from his own observations." It appears, then, that he had simply learnt that marine fossil shells had been met with somewhere in the island of Teneriffe, a fact well known before his visit in 1856, and before Mr. Hartung and I were there in 1854. These shells, however, did not occur "on the slopes of the crater," but in the suburbs of Santa Cruz, along the shore to the northeast of the town, a part of the island which is geographically and geologically independent, not only of the Peak, which is more than twenty miles distant, but also of that volcanic chain which extends many miles from the flanks of the great cone, trending in a northeasterly direction. The separation of the Santa Cruz rocks from the chain to which the Peak belongs, will be understood by a glance at the maps of Von Buch and Captain Vidal, and by reference to the view of Santa Cruz which Vidal has given in the margin of his map. The tufaceous breccias and sandstones containing marine shells near Santa Cruz do not conform "to the slope" of any crater or cone. So far as they can be seen, they appear to be nearly horizontal, and occur only at slight elevations above the level of the sea. We were told that the same remark holds good in reference to certain other deposits containing shells, which we did not examine, in the northeastern extremity of the island, still further from the Peak.

In the first of the passages above cited, Prof. Smyth has alluded to fossiliferous strata in the islands of Grand Canary and Palma. In regard to Palma, I may mention that Mr. Hartung and I, when we were there in 1854, searched in vain for fossils; no travellers had then found any; and our correspondents in the Canaries have still no knowledge of any having been obtained in that member of the Archipelago.

Lastly, as to the Grand Canary, Von Buch was, I believe, the first to call attention to the existence of marine shells in that island, where Mr. Hartung and I collected them in abundance in 1854, and ascertained that they are imbedded in nearly horizontal strata continuous over a large area, where they form an elevated platform about four hundred feet high, near the town of Las Palmas, a platform terminating abruptly in a range of cliffs near the sea, facing the northeast. These upraised sedimentary strata, with some intercalated basaltic beds, are far removed from the slopes of the great dome-shaped volcanic mass, which forms the central nucleus of the Grand Canary; and if they have any bearing on the question of "Craters of Elevation," they certainly do not corroborate that hypothesis, but, on the contrary are directly opposed to it; for though they have been upheaved in a district where intermittent volcanic action has never ceased, they do not dip away in all directions from a central axis, nor have they assumed a conical or dome-like form.

7. *The Old Glaciers of Switzerland and North Wales;* by Prof. A. C. Ramsay, F.R.S and G.S. London: Spottiswoode & Co. 1859. 8vo, pp. 69, with a map and 14 woodcuts.—This charming essay recalls in vivid coloring the reality of that icy episode in the history of Wales, of which every geological observer has seen there such salient proofs since

Agassiz and Forbes first taught us to open our eyes to the truth on this subject. Those who have not visited the classic scenes of Wales will find the excellent woodcuts of this essay quite a valuable substitute for personal observation.

III. BOTANY.

1. *Eulogy on Robert Brown;* by Dr. Von Martius (translated from the German by Prof. Henfrey, and published in the Annals and Magazine of Natural History for May, 1859).—An eulogy upon "the greatest '*Pflanzenkenner*,' the world has yet produced," pronounced by one of his most distinguished survivors and intimate friends. One so learned, so genial, and so philosophical as Von Martius, cannot fail to interest and instruct, although somewhat of the glow and animation which we expect in the original may be lost in the translation. We are pleased to learn the curious fact, that a humble but peculiar North American plant, which has somehow found its way to the Irish and North British shores, may be said to have fixed the destiny of the great Botanist. Upon the completion of his medical studies, Brown, as is well known, was attached as ensign and assistant surgeon to a Scotch militia regiment stationed upon the western coast of Ireland.

"An inconspicuous plant with which he there became acquainted—the *Eriocaulon septangulare*,—the only European representative of an especially American order—caused his life to be diverted into the exclusive service of botany; for, accompanying a recruiting party of his regiment to London, in the summer of the year 1798, and on the road visiting his friend Dr. Withering at Edgbarton, near Birmingham, the latter caused him to introduce himself, with that plant and his researches upon it, to Dr. Dryander. This learned botanist, librarian to Sir Joseph Banks, astonished at the minuteness of the investigation, and the fullness of the conclusions derived therefrom, recommended the young military surgeon as a future master in botany; and Sir Joseph Banks from this time forward showed him a paternal kindness. He welcomed him as a regular guest at the celebrated literary breakfasts, during his five months' stay in London, and in December, 1800, proposed him to the Government as Naturalist to the naval Exploring Expedition to New Holland, under Capt. Flinders, then fitting out. Robert Brown, at this call, gave up at once the military career, came again to London at Christmas, 1800, and on the 18th of July, 1801, sailed in the 'Investigator' from Spithead to the newly discovered quarter of the globe." A. G.

2. *Fragmenta Phytographiæ Australiæ, contulit* Ferdinandus Mueller, Ph.D., M.D., Gubern. Col. Victoræ Phytologus, Hort. Bot. Melbournensis Director, etc., etc. Melbourne. Vol. I, fasc. 1—4, (pp. 96), 1858–9.—The British California in the southern hemisphere,—more enlightened and more spirited than our own,—has officially organized and promoted scientific research from the first. The colony has not only its Philosophical Institute, publishing memoirs of high character, but its Botanic Garden, Museum and Herbarium, under the charge of a Government Botanist, the able and indefatigable Dr. Mueller. Nor do they confine the energies of this officer to the Victoria Colony, but spared him to accompany, as botanist, the recent exploration by Capt. Gregory

of the northern part of the great Australian continent, where an extensive and interesting herbarium was gathered. A most enthusiastic and industrious botanist himself, Dr. Mueller awakes the interest and stimulates the activity of others; and vast collections, abounding in novelties, are rapidly accumulating in his hands. He has already published numerous scattered papers, in Germany, England and Australia. The publication now commenced has the advantage of a more convenient, connected form, and contains the characters of new genera and species, and rectifications of those published before, with important critical remarks, &c. A. G.

3. *Journal of the Proceedings of the Linnæan Society* (*Botany*), Nov. 12, (1859): contains, 1st, the latter half of Prof. Henfrey's *Note on the Morphology of the Balsaminaceæ.* Balsams double [as do most blossoms] by an increase in the number of the whorls of the petals; and when merely one extra whorl of petals is developed, Prof. Henfrey finds these to alternate regularly with the five pieces which Rœper takes for the corolla; thus confirming Rœper's view (over that of Kunth) by evidence from within, of the same nature as that which *Hydrocera* normally furnishes from without. 2. *On the Arborescent Ferns of New Zealand;* by Thomas S. Ralph:—an instructive, popular account of their trunks and mode of growth. 3. *The Indian species of Utriculariæ;* by Daniel Oliver. Apparently an excellent monograph; the Indian species reduced to about two dozen. 4. *On five New Plants from Peru;* by Richard Spruce.

The botanical contributions to the Journal having much exceeded the zoological in amount, the excess is to be issued in supplemental botanical numbers. The *Supplement to Botany*, No. 1 and No. 2 have appeared, and contain the *Musci Indiæ Orientalis; an Enumeration of the Mosses of the East Indies;* by Wm. Mitten. This paper fills 171 pages, including an index to the species, and introduces some bold reforms in bryology.

4. *Synopsis Hymenophyllacearum, Monographiæ hujus ordinis Prodromus.* Auctore R. B. Van der Bosch, M. D. Leyden. pp. 79, 8vo. A separate impression from the *Nedrl Kruidk Archief*, Dec. 1858.—Dr. Van der Bosch, having in preparation a general monograph of this most elegant group of Ferns, illustrated by figures, has issued this precursory Synopsis. It contains a classified arrangement of the known species, the habitat, most important synonymy, and the characters of a few new species. The two old genera of this group—retained entire by Hooker, but divided into nineteen by Presl,—are here distributed into nine genera, with amended characters; viz:—*Cardiomanes*, Presl, *Feca*, Bory; *Neuromanes*, Trevis; *Cephalomanes*, Presl; *Trichomanes*, Smith (with about 114 known species); *Didymoglossum*, Desv.; *Leptocionium*, Presl; *Hymenoglossum*, Presl; and *Hymenophyllum* (140 species). Carrying his experience as a Bryologist into this analogous field of enquiry, our author finds available specific characters in the cellular structure of the frond. By such characters he distinguishes *Trichomanes brevisetum* from *T. speciosum*, and both from *T. radicanes.* A. G.

5. *The Botany of the Mexican Boundary. Introduction* by C. C. Parry. *Botany of the Boundary*, by John Torrey, M.D. *Cactaceæ*, by George Engelmann, M.D. This forms the first half of that ponderous tome

(almost half as thick as it is wide), the second volume of the *Report on the United States and Mexican Survey* by Col. Emory, and it must be ranked as the most important publication of the kind that has ever appeared. Dr. Parry's interesting Introduction is brief. Dr. Torrey's systematic account of the general botany extends to p. 270, and is illustrated by 61 plates, most of them well-chosen as to the subject, and all admirably drawn by Riocreux, Sprague, and a few by Hochstein. Dr. Engelmann's important memoir on the *Cactaceæ* occupies 78 pages of letter-press and is adorned by 75 plates of surpassing excellence. This and its counterpart, the *Cactaceæ* of the Expedition under Lieut. Whipple (of which Dr. J. M. Bigelow was the botanist), published in the fourth volume of the Explorations and Surveys for a Pacific Railroad Route, and illustrated by 24 plates, elucidate a large, peculiar, and most characteristic order of our wide south-western regions in a manner which must command universal admiration, and must assign to the author a high rank among the systematic botanists of our day. The general Botany of the same expedition, by Dr. Torrey, founded upon one of the best collections ever made in such a journey, and illustrated by 25 plates, is worthy of equal praise.

But all these memoirs are sadly marred by typographical errors. A government printing office is not well adapted for this sort of work, and proof-reading from a distance seems to be ineffectual. The zoological reports are much better printed, doubtless, because the author on the spot could insist upon a sufficient revision of his proofs, and see that his corrections were attended to. The disfigurements which we notice in these are prepense, and are caused by the depraved taste which writes the names of people with a small, instead of a capital initial letter; e. g. *edwardsii*, *clarkii*, *ordii*, *henryi*, and so on, *usque ad nauseum*. Though why they should be so decapitated when genitives after a generic name, although honored with a capital initial when they follow a specific name, passes ordinary comprehension. Consistency would seem to require uniformity like this: *Chordeiles henryi*, baird. Returning to the Botany, with which alone we are at present concerned, we remark that it would have been most convenient and acceptable to botanists to have cited the numbers of Wright's distributed collections throughout, and also, as far as possible those of Fendler, Lindheimer, and of Berlandier's posthumous distribution. A systematic catalogue of all the plants enumerated and described in these various Western Expeditions, or rather a complete catalogue of the species of the United States west of the 100th parallel of longitude, including those of the Mexican border, is now very much wanted. A. G.

6. *Catalogue of the Phænogamous and Acrogenous Plants contained in Gray's Manual of the Botany of the Northern United States, adapted for marking desiderata in exchanges of specimens, etc.* New York: Ivison & Phinney. 1859.—A help of this sort in making exchanges has often been asked for, and the enterprising publishers of Gray's Manual have responded to the demand by publishing, at a low price, this neat Catalogue, for which good office they deserve the best thanks of our scattered botanists. The species are numbered consecutively, from No. 1, *Atragene Americana* to 2421, *Azolla Caroliniana.* The list, in double columns, fills thirty-two pages of the same size as those of the Manual

itself. A cent stamp will pay the postage of the pamphlet to any part of the United States; and the sender has only to indicate to his distant correspondent, by marking or by copying the numbers, the species which he desires to receive or is able to furnish. Moreover, the names of the orders, which are printed in bold type, and even those of the genera, may serve another useful purpose: they may be cut out and used for labels in the herbarium. A. G.

IV. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *The Thirteenth Meeting of the American Association for the Advancement of Science* was held August 3–9, 1859, at the City Hall in Springfield, Massachusetts.—The Springfield meeting of the American Association passed off with decided success; the greatest harmony and good feeling prevailed. A large gathering of members from all parts of the United States and Canada and foreign countries enjoyed the graceful hospitalities of one of the most beautiful cities in New England. The number of members in attendance was estimated to be about five hundred. The weather throughout was as fine as possible, and the excursion to Amherst College under the escort of the venerable and distinguished Dr. Hitchcock, was an occasion long to be remembered as one of the golden days of life. Members seemed lost in admiration of the romantic loveliness of the scenery surrounding the College, and in the unexpected extent, richness, and high condition of the scientific collections, unequalled certainly by those of any other college in the United States. Here Dr. Hitchcock has built up a lasting monument of his original labors in the curious department of foot-marks on the Connecticut sandstone. This vast collection, vast both in the numbers and magnitude of its specimens, is now preserved in "Appleton Hall," a new building erected specially for its accommodation, and on the ground floor of which these curious records of lost races once denizens of this lovely valley are spread out to the inspection of visitors. No one can form an adequate notion of the interest of these remarkable collections without a personal inspection.

Whatever the *Black stone* of Mecca may prove to be, meteorite or porphyry, the scientific pilgrim to Amherst will be rewarded by an inspection of the largest and most important collection of meteoric specimens in the world, excepting that of the Imperial Museum of Vienna. By the untiring exertions of Prof. Shepard, 124 meteoric discharges are here represented, in choice and unblemished specimens. The Vienna cabinet is stated in Mr. Haidinger's paper of Jan. 7, 1859, to contain 137 localities.

The mineralogical collection of Prof. Shepard at Amherst is worthy of most particular notice. In the richness and splendor of its selections, the mineral species are nowhere in America and seldom anywhere so well represented. Choice specimens seem to have come to this celebrated collector's hands like the fabled fish of the wierd fisherman. Whatever was most rare or choice from any locality appears to have found no rest until it was safely placed on his shelves.

No wonder then that amid such surroundings and with beauty and festive speech at the hospitable tables covered by the fair hands of Amherst ladies, the Association was beguiled to view the glories of a midsummer sunset over the picturesque ranges of the Northampton hills, or

that they returned to Springfield late in the evening full of the praises of the day and its rich entertainments.

We append a list of the officers of the Springfield meeting, and also of the papers registered.

Officers of the Association, Springfield meeting.—President, Professor Stephen Alexander.—*Vice President,* Prof. Edward Hitchcock.—*Permanent Secretary,* Jos. Lovering.—*General Secretary,* Wm. Chauvenet.—*Standing Committee,* Professors Stephen Alexander, Jeffries Wyman, William Chauvenet, Joseph Lovering, Edward Hitchcock, John E. Holbrook, A. L. Elwyn, Alexis Caswell, W. M. Gillespie, Benjamin Peirce, A. D. Bache, B. Silliman, Jr., Joseph Leconte, Wolcott Gibbs, J. W. Foster, Esq.—*Local Committee,* Hon. George Bliss, *Chairman.*—Dr. George A. Otis, Jr., *Secretary.* R. A. Chapman, Esq., Rev. Francis Tiffany, George M. Atwater, Capt. James Barnes, Samuel Bowles, Ansel Phelps, Jr., Esq., Hon. C. C. Chaffee, Chester W. Chapin, Col. J. M. Thompson, George Walker, Esq., John L. King, Gen. James S. Whitney, Ethan S. Chapin, Josiah Hooker, Esq., A. D. Briggs.—*City Committee,* Mayor William B. Calhoun; Aldermen Roger S. Moore and Horace Smith; Councilmen Gurdon C. Judson, Reuben T. Safford, Joshua M. Harrington, Walter North.

*List of papers registered for presentation to the Association.**

1. On the Origin of the Azoic Rocks of Michigan and Wisconsin; by Charles Whittlesey.

2. On the Drift Cavities, or "Potash Kettles" of Wisconsin; by C. Whittlesey.

3. General Account of the Results of the Discussion of the Declinometer Observations made at Girard College, Philadelphia, between the years 1840 and 1845, with special reference to the Eleven Years' Period; by A. D. Bache.

4. Distribution of Temperature in the Florida Channel and Straits; by A. D. Bache.

5. Comparison of the Amount and Frequency of Rain with different Winds on the Western Coast of the United States; by A. D. Bache.

6. Abstract of the principal results of the Observations of Temperature at Van Rensselaer Harbor, North Greenland, made by the second Grinnel Expedition under command of Dr. E. K. Kane, U. S. N., during the years 1853–4–5; presented by A. D. Bache, from a reduction and discussion by Charles A. Schott, assistant in the Coast Survey.

7. Abstract of the principal results of the Discussion of the Observations for the Direction and Force of the Wind at Van Rensselaer Harbor, North Greenland, made by the second Grinnel Expedition, under the command of Dr. E. K. Kane, U. S. N., in 1853–4–5; presented by A. D. Bache, from a reduction and discussion by Charles A. Schott, assistant in the U. S. Coast Survey.

8. Abstract of the principal results of the Discussion of the Observations for Atmospheric Pressure at Van Rensselaer Harbor, North Greenland, made by the second Grinnel Expedition under command of Dr. E. K. Kane, U. S. N., during the years 1853–4–5; presented by A. D. Bache, from a reduction and discussion by Charles A. Schott, assistant in the U. S. Coast Survey.

9. On the Occurrence of Pot Holes, (or pot-shaped excavations, caused by the gyration of pebbles,) formed by the Drift Agency; by Oliver Marcy.

10. On the marks of Ancient Glaciers, on the Green Mountain Range in Massachusetts and Vermont; by Charles H. Hitchcock.

11. Lake and Pond Ramparts in Vermont; by Charles H. Hitchcock.

* The asterisk prefixed indicate papers not read, and should probably be attached to some others not certainly known to the Editors.

12. On the so-called Talcose schist of Vermont; by Charles H. Hitchcock.
13. Dykes of Trachyte and Conglomerate in Shelburne, Vt.; by C. H. Hitchcock.
14. Conglomerate Syenite Porphyry and Granite in Vermont; by Charles H. Hitchcock.
*15. On the Circulation of the Ocean; by Charles Wilkes.
16. Some Observations on Ozone; by John Brocklesby.
17. Contributions on the subject of Frozen Wells and Cold Springs; by John Brocklesby.
18. On cutting the Threads of Male and Female Screws, so that they shall commence and terminate at any desired points with precise uniformity and correspondence; by Cyrus Buckland.
*19. A method for discharging the Leyden Jar, by employing an Imperfect Conductor; by C. B. Chapman.
20. Origin, Direction, and Progress of Storms in the United States, east of the Rocky Mountains; by Chester Dewey.
21. On the Mass of the Moon; by Stephen Alexander.
22. A question as to the Earth's Dimensions and Metre; by Stephen Alexander.
23. A brief note on Comets; by Stephen Alexander.
24. On the Harmonies and the Ancient History of the Solar System; by Stephen Alexander.
25. On the Common Origin of the Asteroids, and also of some of the Comets of short period; by Stephen Alexander.
26. On the Causes of the Variation of Temperature of the Seasons; by G. W. Burnap.
27. On the Theory of the Comet's Tail; by Benjamin Peirce.
28. On the History of the Investigation of the Physical Constitution of Comets; by Benjamin Peirce.
29. On the Personal Peculiarities of Astronomical Observers; by Benj. Peirce.
30. On the Possible Causes of the observed Geological Changes in the Earth's Temperature; by Benjamin Peirce.
31. On the Secular Perturbation of four of the Asteroids; by Simon Newcomb.
32. On the Mathematical Theory of Music; by T. H. Safford.
33. On the Determination of a Comet's Orbit; by T. H. Safford.
34. On a new method of investigating Plane Curves, with its application to Evolutes and Caustics; by William Watson.
35. On Meteorology; by Joseph Henry.
36. An Analysis of the Laws which determine the Action of the Centrifugal Governor; by Charles J. Porter.
37. The Indian Mode of bestowing and changing Names; by L. H. Morgan.
38. Researches on the Platinum Metals; by Wolcott Gibbs.
39. A Systematic Reference Catalogue of all the described North American Lepidoptera; by John G. Morris.
40. The complete Semicircle of the Zodiacal Light, as seen at night recently by various observers; by George Jones.
41. The occasional luminousness of the Atmosphere at night, as observed on the summit of the Andes; by George Jones.
42. On the European Storm of Dec. 25, 1836; by Elias Loomis.
43. On the alleged Lunar Origin of Aerolites; by B. A. Gould, Jr.
44. On the occurrence of bones and teeth in the lead-bearing crevices of the Northwest; by J. D. Whitney.
45. On certain Curves treated by new Coördinates; by Thomas Hill.
46. On the Scope and Method of Linguistic Science; by W. D. Whitney.
47. Certain Arts which distinguish Nations of the Eastern World from the Aborigines of this Western Continent; by J. H. Gibbon.
48. Is Indian Corn (*Zea Mays*) a native of three continents, like Cotton and Tobacco? by J. H. Gibbon.
49. Winds of the Southern Hemisphere; by James H. Coffin.
50. On the Hindu Astronomy; by W. D. Whitney.
51. On the Lasso-Cells of Polypi and Acalephæ; by H. J. Clark.
52. On the Facetted Eyes of Acalephæ, especially of *Aurelia flavidula*; by H. J. Clark.

53. On apparent equivocal Generation; by H. J. Clark.
*54. On a supposed Meteorite of a new Chemical Constitution from North Carolina; by C. U. Shepard.
*55. On an Examination of the Matter of a supposed Shooting Star that fell on the eve of November 16th, 1857, at Charleston, S. C.; by C. U. Shepard.
56. Vibrations in the Water-fall at Holyoke, Mass.; by E. S. Snell.
57. System of Consanguinity of the Red Race, and its relations to Ethnology; by Lewis H. Morgan.
58. On a Frozen Deposit of modified Drift in Brandon, Vermont; by Edward Hitchcock.
59. On the Conglomerate near Newport, R. I., with elongated pebbles and transverse joints; by Edward Hitchcock.
60. On a Deposit of Fossiliferous Limestone beneath Granite and Mica slate in Derby, Vermont; by Edward Hitchcock.
61. An attempt to prove that the younger Metamorphic Rocks have been in a plastic or semi-plastic state since their original consolidation; by E. Hitchcock.
62. On the Amount and Proofs of Erosion in Vermont, with special reference to Peaks of protrusive rocks; by Edward Hitchcock.
63. Recent Discoveries in the Devonian and Carboniferous Flora of British America; by J. W. Dawson.
64. The means of preventing the Alteration of Metallic Surfaces employed to close and break a voltaic circuit; by F. A. P. Barnard.
65. On the sudden Disappearance of the Ice of our Northern Lakes; by J. G. Totten.
66. On Nitride of Zirconium; by J. W. Mallet.
67. On the Atomic Weight of Lithium; by J. W. Mallet.
68. On Osmious Acid, and the position of Osmium among the Elements; by J. W. Mallet.
69. On the Vertical Planes in Bituminous and other Coals; by E. B. Andrews.
70. On the Terraces along the Rivers in Southern Ohio; by E. B. Andrews.
*71. On the Zoomorphic Sandstone of the Connecticut Basin; by Joseph Barratt.
*72. On the Discovery of a Creature (*Kamdactylus sub-humanus*), the Antetype of Man; by Joseph Barratt.
73. Ornithichnites; by Roswell Field.
*74. On the Geometrical Construction of Curves of degrees higher than the second, having given multiple points; by H. A. Newton.
75. The Correlation of Physical, Chemical and Vital Forces, and the Conservation of Force in Vital Phenomena; by Joseph Leconte.
76. On the Formation of Continents and Oceans; by Joseph Leconte.
77. Observations on the Geology of the Rocky Mountains in the vicinity of Santa Fe, New Mexico; by William P. Blake.
78. Physical Constitution of Comets; by W. A. Norton.
79. On the alleged occurrence of Sand in Maple Sugar; by E. N. Horsford.
80. On the Source of Carbonate of Lime in Organic Structures occurring in Sea-water; by E. N. Horsford.
81. On some recent Determinations of the Carbonic Acid in the Waters of the Congress Springs of Saratoga; by William E. Hughes, presented by E. N. Horsford.
*82. Some experiments made at the Lawrence Scientific School, on the heating powers of luminous and non-luminous Flames; by G. A. Gould, presented by E. N. Horsford.
*83. On the Prevention of Fermentation in the Juices of Fruits, by means of Sulphite of Lime; by E. N. Horsford.
84. Theoretical Explanation of the similarity between the Flora of Northeastern Asia, and that of Eastern North America; by Asa Gray.
85. Note on the Discharge of Atmospheric Electricity through Gas Mains; by Benjamin Silliman, Jr.
*86. On the application of Electric Conductors to Buildings; by L. F. Locke.
87. Remarks on the Restored Skeleton of the Fossil Whale of Charlotte, Vt.; by Edward Hitchcock, Jr.
88. On some applications of the principle of Relative Motion to the determination of the Areas of Closed Curves; by George Eastwood.

89. **On the use of a Transit-Circle as a substitute for the Zenith Telescope in the** determination of Latitude; by C. S. Lyman.
90. Instruments for measuring the Depth of the Ocean; by W. P. Trowbridge.
91. On the Stratigraphical Position of the Sandstone of the Connecticut Valley; by J. D. Whitney.
92. On a remarkable Vein of Gold in the bed of the Chestatee river, Georgia; by W. P. Blake.
93. The Placer Gold Mines of Georgia, and the introduction of improved methods of working them; by W. P. Blake.
94. Remarks on the Minerals and Ancient Mines of the Cherokee Valley River, North Carolina; by W. P. Blake.
95. Contribution to the History of the Laurentian Limestones; by W. E. Logan.
*96. On "Anhydrous Fermentation;" by L. F. Locke.
97. On some Reactions of the Salts of Lime and Magnesia; by T. S. Hunt.
98. On the Paradox of the Coexistence of Excessive Production and Excessive Population; by Clinton Roosevelt.
99. On the Formation of Gypsum and Magnesian Rocks; by T. S. Hunt.
100. On the Origin and Formation of Silicious Rocks; by T. S. Hunt.
101. The Relations of the Upper Carboniferous Rocks of Illinois to the older members of the Palæozoic System; by J. H. McChesney.
102. Remarks on the Discovery of a Terrestrial Flora in the Mountain Limestone of Illinois; by A. H. Worthen.
103. On the Composition of Pectolite; by J. D. Whitney.
104. On Magnetizing Locomotive Wheels by Curved Helices, and the Experimental Results; by Edward W. Serrell.
105. Vital Observations and Statistics as Data for the Formation of Natural Life-Tables; by E. B. Elliott.
106. Experiments on Induction-Time in Electro-magnets in Telegraph Lines; by A. D. Bache and J. E. Hilgard.
107. On Certain Phenomena of the Great Dismal Swamp in Virginia and North Carolina; by Nathan B. Webster.
108. The Causes of Steam-boiler Explosions; by James Hyatt.

The officers of the Association for 1860 are: President, Isaac Lea, of Philadelphia; Vice President, B. A. Gould, Cambridge, Mass.; General Secretary, Joseph LeConte, of Columbia, S. C.; Treasurer, A. L. Elwyn, of Philadelphia.

The next meeting will be held at Newport, R. I., on the first of August, 1860. The warm waters of that shore will offer a rich treat to the naturalists who will unquestionably assemble at Newport in unwonted numbers.

The address of the retiring president, Prof. Alexis Caswell of Brown University, after paying a deserved tribute to the memory of deceased members, was a sketch of American progress in his favorite science of Astronomy. It will be published in the Transactions of the Association.

Among the attractions already visible for the Newport meeting will be—by appointment of the Association—a discourse by Prof. Joseph Henry, commemorative of the life and scientific labors of Dr. Robert Hare; and an address by A. D. Bache on the Gulf Stream. It is equally interesting and appropriate that the labors of his great grandson should have contributed so signally to enlarge our knowledge of this wonderful river of the sea, which Dr. Franklin was the first to bring to the general notice of the scientific world. Dr. Jos. Leidy was also requested to address the Association at Newport upon the extinct Reptilia and Mammalia of North America.

2. *Scientific versus Practical Instruction.*—The following testimony of Liebig as to his famous school at Giessen, is worth considering in these days of schools of practical science.

"The technical part of an industrial pursuit can be *learned:* principles alone can be *taught.* To learn the trade of husbandry the agriculturist must serve an apprenticeship to it; to inform his mind in the principles of the science he must frequent a school specially devoted to this object. It is impossible to combine the two; the only practicable way is to take them up successively. I formerly conducted at Giessen a school for practical chemistry, analysis, and other branches connected therewith, and thirty years' experience has taught me that nothing is to be gained by the combination of theoretical with practical instruction. It is only after having gone through a complete course of theoretical instruction in the lecture-hall that the student can with advantage enter upon the practical part of chemistry. He must bring with him into the laboratory a thorough knowledge of the principles of the science, or he cannot possibly understand the practical operations. If he is ignorant of these principles, he has no business in the laboratory. In all industrial pursuits connected with the natural sciences, in fact, in all pursuits not simply dependent on manual dexterity, the development of the intellectual faculties by what may be termed school learning, constitutes the basis and chief condition of progress and of every improvement. A young man with a mind well stored with solid scientific acquirements will, without difficulty or effort, master the technical part of an industrial pursuit; whereas in general, an individual who is thoroughly master of the technical part may be altogether incapable of seizing upon any new fact that has not previously presented itself to him, or of comprehending a scientific principle and its application."—*Liebig, Letters on Modern Agriculture, edited by John Blyth, M.D.*

3. *Dr. Newberry's late Explorations in New Mexico—he shows Marcou's so-called Jurassic to be Cretaceous.*—Advices have been received from Dr. Newberry at Santa Fé, N. Mexico, as late as July 18th, in letters to Mr. Meek. Dr. N., following the Santa Fé road from Independence, Mo., to near Burlingame, Kansas, saw nothing but rocks of the upper Coal measures, but near Burlingame, on the banks of Dragon creek, he found the first Permian forms [the dip in all this region is N.W.] From Wellington to Cottonwood and Turkey creek the Permian was constantly found in the hill-tops, but the valleys were excavated down to the Carboniferous. The Permian was a light cream-colored Magnesian Limestone. From the Little Arkansas to Walnut creek the surface rocks were Red, Yellow and White Marls and Gypsum, so characteristic of the Llano Estacado and the country west of the Rio Grande. There were no fossils. These are the beds seen by Meek and Hayden and described by them as between the lower Cretaceous and the Permian in Kansas, some 35 to 40 miles farther to the northeast, and which rocks they state in their paper may be either Jurassic or Triassic—but they (like Dr. Newberry) discovered no fossils in them.

On the banks of Walnut creek, a tributary of the Arkansas—a little farther west, Dr. Newberry saw the same red or brown sandstone from which Messrs. Meek and Hayden collected the fossil leaves on Smoky Hill

river, some 40 or 50 miles farther to the northeast, and also in Nebraska at the Blackbird Hills. In this sandstone and in a gray clay beneath it, he also has found some of the same "leaves of dicotyledonous trees—Willows, &c., precisely as at Smoky Hill, Blackbird Hills and in New Jersey." These leaves Dr. Newberry pronounces the same which mark the base of the Cretaceous in New Jersey, Nebraska and Kansas. These are the leaves declared by Prof. Heer and Mr. Marcou to be *Miocene!*

The Cretaceous beds at this point were not seen by Dr. Newberry overlying the sandstone, but on the Canadian, further southwest, as we might expect from the dip, he found this *same sandstone overlaid by the same Cretaceous seen by Meek and Hayden surmounting it in Nebraska*. In these Cretaceous beds,—a whitish marly limestone and shale (Nos. 2 and 3 of the Nebraska Section of Meek and Hayden, the Sandstone being No. 1,)—he found *Inoceramus problematicus*, a well known Cretaceous species (so in England and various parts of Europe,) as well as in No. 3 of the Nebraska Section,—associated with *Ammonites New-Mexicana*, *Gryphæa Pitcheri* (*G. dilatata*, var. *Tucumcarii* of Marcou). Thus we have the same stone which Mr. Marcou and Prof. Heer would make *Miocene*, *overlaid* by beds containing not only well known and admitted Cretaceous fossils, but along with these the very *Gryphæa* relied upon by Mr. Marcou for the establishment of the existence of the *Jurassic*. So if Mr. Marcou and Prof. Heer are right, the Miocene proves to be older than the Cretaceous and the Jurassic! and the unfortunate American geologists find to their confusion that the roof of their geological edifice was constructed before the foundation was laid.

Dr. Newberry states also, "at Galisteo I found upper and lower Cretaceous rocks beautifully exposed, and in the *lower Cretaceous Sandstone* (Jurassic of Marcou) *dicotyledonous leaves*." "The [true] Jurassic may be in New Mexico," he continues, "but we have not yet detected it—Marcou's Jurassic is certainly not so."

The facts elicited by Dr. N. seem however to sustain the Trias in New Mexico. Writing from Abiquia (near Santa Fé), N. Mexico, he says: "Here in the red gypsum-bearing marls—the 'Gypsum formation' of Blake, and the 'Marl Seams' of Dr. N.'s former report he finds extensive deposits of copper—copper schists and copper conglomerate, precisely as the copper schists of Europe." The red gypsum-bearing rocks here referred to as embracing the copper schists are probably the same seen by Meek and Hayden in Kansas between the Permian and the Lower Cretaceous, and which they were disposed to refer to the Jurassic or Triassic.

The most important evidence however, of the age of these deposits, is in the occurrence in them of Cycadaceous plants—*Zamites*, *Pterophyllum*, &c., which are, in Dr. N.'s opinion, similar to those of the Keuper (Upper Trias) of Europe; but he reserves a positive assertion on this point until he can compare his New-Mexican forms more carefully with the European species than is possible in the field.

Dr. Newberry's route lay from Abiquia, the day after his latest date (July 18th) towards the country near the mouths of the San Juan, which, from all accounts, is a paradise for the geologist, but very much the reverse for other people. He hopes to exhibit his interesting collections to his geological friends in the United States by the end of October.

4. *Meteor of August* 11, 1859.—On the morning of the 11th of August, at 7 o'clock and 20 minutes, or thereabouts, thermometer 73° F., air still and without clouds, two violent and successive explosions or reports (one witness, Mrs. Ball, says there were three,) were heard over a district of country, extending in an east and west line, from Blandford, in Hampden county, Massachusetts, to some ten miles west of the cities of Troy and Albany on the Hudson—a distance of about 100 miles;—and in a north and south line from Bennington, Vt., to Columbia Co., N. Y., a distance of about 80 miles.* The noise, which has been compared by some, to two successive, sharp and heavy peals of thunder, and by others, to the report occasioned by the explosion of a steam-boiler, or powder-mill, was accompanied by very distinct and prolonged echoes, and appears to have been noticed most sensible, and to nearly an equal degree, in Troy, Greenbush, Lansingburg, Waterford, Grafton, and New Lebanon, in N. Y., at Bennington in Vermont, and in the vicinity of Pittsfield, Mass. At Troy, the concussion was so great that houses were shaken, and people walking in the streets were conscious of a vibration of the earth. At Schaghticoke, N. Y., and Bennington, Vt., where powder-mills are in operation, the report was referred by the citizens to explosions at the works. At Schaghticoke, when the managers of the powder-works ascertained that no explosion of mills had taken place either in their own town or in Bennington, they at once concluded that a train of waggons despatched from their works for Troy, a few hours before, with powder had been blown up, and messengers were sent with haste in pursuit of them. At Eagle Bridge, on the Troy and Bennington railroad, the concussion was forcible enough to jar the windows and shake the seats in a train of cars in motion. At Schodack, on the Springfield and Albany railroad, men who were at work in the fields heard the report and felt the shock with great distinctness, and at Greenbush, a large number of people rushed to the docks, expecting that a steamboat had burst its boiler.

As to the cause of the phenomenon;—a great abundance of concurrent testimony, seems to prove, that it was due to the explosion of an immense meteor at a considerable distance above the surface of the earth. This evidence, so far as we have been able to collect it is, as follows:—

John P. Ball, County Clerk of Rensselaer Co., N. Y., in a letter to the editor of the Troy Times, states: "that as he was standing in his dooryard, just after breakfast, he observed a bright body in the air, descending very rapidly to the ground in a northwesterly direction. When apparently about a half a mile above the earth, it disappeared, and in a moment or more he heard the explosion. It was very loud and resembled thunder. He had previously called his family to view the meteor, and they all observed the light and heard the explosion. Mrs. Ball insists that there were three separate explosions—one much louder than the others—and in support of her statement, Mr. B. says he saw three distinct clouds of smoke in the track of the meteor, which appeared to be a mile or more apart. The smoke was visible for some time, but was finally lost to sight. The meteor appeared to be at a distance of about twenty miles from Mr. Ball's residence."

* The limits, as here given, are based upon positive information; they may, however, possibly have been much more extensive.

Ezra Turner and son, of North Schaghticoke, N. Y., three miles north of Mr. Ball's residence in Grafton, observed the meteor distinctly, and heard the explosion.

At New Lebanon, N. Y., it was seen by two members of the Shaker community to pass over their town in the direction of Troy, and was apparently as large as a "flour barrel."

At Hoossic, N. Y., it was also observed, together with the cloud of smoke that followed the explosion. A lad living in the easterly limits of the city of Troy, N. Y., saw a ball of fire in the air, and called his family to look at it. As he did so the extraordinary report was heard, and those who looked in the direction he indicated, saw a small but dense cloud of smoke.

Under date of Aug. 13th, 1859, J. R. Simmons of Berlin, N. Y., writes to the editor of the Troy Whig, as follows:—"I was standing in front of my house on Thursday morning, the 11th inst., at 7 o'clock and 20 minutes,—there being a cloudless sky or very nearly so,—when my attention was suddenly attracted upwards. I saw a meteor of gigantic size, passing between the perpendicular and the altitude of 65°, towards the southwest, in a horizontal line, with great velocity, remaining in sight several seconds, and leaving trails of smoke at intervals. The color was red, like lights thrown from a roman candle, and had connected with it all the rainbow hues. While it was passing in sight. I remarked to the Rev. J. D. Rogers and my family, 'there's a rocket;' they did not get to the door before it had passed out of sight, leaving nothing but the trails of smoke for them to see. While we were looking at these, I remarked to Mr. R., that I had never seen a meteor previous to this, without hearing sound produced like a fireball in its flight through the air, or like the report of a fowling gun when discharged. After the lapse of five minutes we all heard the [qu. *three?* Eds.] heavy peals, more terrible than thunder, jarring the earth as well as the atmosphere. I have heard so many conjectures in relation to what produced the terrific report, and most of them so remote from the real cause, that I have given you a correct description of the whole scene that has caused so many remarks."

At Livingston, Columbia Co., N. Y., the meteor was observed in the north, "*with strips of apparent smoke, and a long rumbling sound.*"

Under date of August 18th, 1859, Emory F. Strong of South Manchester, Connecticut, writes to the editors of the Hartford Courant as follows:—"About twenty minutes before eight o'clock on the morning of the 11th, I was standing with a friend in a position facing the northern horizon, when our attention was attracted by an unusual appearance in the heavens—a luminous body, equal to the sun in brightness, was seen about ten degrees west of the meridian, and passing rapidly in a westerly direction; when within apparently twenty degrees of the horizon it disappeared for an instant and then on reappearing seemed to explode. Its last appearance was not unlike that of a large sky-rocket in the act of explosion. We listened for the report but heard none. The sun was shining brightly at the time, which would have rendered the phenomenon invisible to all except those whose attention for the moment happened to be directed to that particular portion of the heavens."

A correspondent of the N. Y. Evening Post, writing from New Lebanon, N. Y., gives the following account of this phenomenon as observed

in that vicinity:—"About 7 o'clock on that morning as I was about to leave my bed chamber, I was startled by two distinct and very heavy explosions, so that I immediately ran to the window and looked over toward the Shaker village hill, where I knew they were blasting stones to build the great dam in that village, but could see no smoke at all, the sky being clear and the weather beautiful. The noise was so startling as to call the attention of every one about the premises, and various persons in our house (a large farm house) went out of doors, and others to the window, to see what was the matter. The *house trembled* so as to be noticed by all of us—a family of over twenty people, and more than half were in the house at the time.

"We supposed some powder mill had exploded, but heard during the day that two of the 'Shakers,' Messrs. Calvert and Chase, (two miles from here,) who were out in the field, had their attention drawn to a bright light in the sky, when they saw a meteor, which exploded apparently in the vicinity of Pittstown, and immediately the great report followed. They were looking north, while my window looked south, but I might not have seen the meteor if I had looked north, as the two 'Shakers' were on a high hill, while I was in a valley. [This fully confirms Mr. Ball's account].

"My brother, with three others of our family, was riding in a carriage, on his way to Canaan to meet the cars, at the time of the explosion, and the noise was so great as to excite remarks from all in the carriage, and to make both the horses jump as though frightened. The noise was heard at all the neighboring villages, and resounded through the valleys and hills like very heavy thunder. It was heard at 'Columbia Hall,' at Lebanon Springs, one and a half miles from here, but not so distinctly as we heard it, as the explosion occurred north of us, and that hotel stands on the south side of a high hill."

From Morristown, Lamoille county, Vermont, twenty-five miles north of Montpelier, Mr. J. M. Chatterton writes, that the meteor was seen at the same time as noticed elsewhere, by himself and others. "The sun was shining brightly at the time, and its course was towards the south."

"A Subscriber" writes to the Boston Journal from "Copperas Hill," Strafford, Vt., confirming the accounts from Troy. He says:—"The same phenomenon was witnessed from this place by two gentlemen who were making investigations in the extensive mines of copper, iron, &c., to be found here. At the same hour above mentioned, their attention was suddenly attracted by a very brilliant object descending in a southwesterly direction, and resembling very much one portion of what is called golden rain in a rocket, only many times larger, and followed by a long train of light. Although the sun was shining brightly, still so intense was the brilliancy of this meteor, or whatever it might have been, that it had the appearance of not being over half a mile off, and we were fully expecting to feel the effects of some great explosion; but its distance was so much greater than we had apprehended, that no shock was experienced."

The Albany Evening Journal of Aug. 20th has the following item:—"Garritt Vanderpool, a well-known and highly respected farmer, lives seven miles from this city, and one mile west of the Bethlehem church. When at work in his barn, on the morning of the mysterious commotion heretofore referred to, and about two minutes after the noise which had attracted his attention had ceased, he heard what sounded like a small

stone thrown against the side of his carriage-house. On looking up, he saw the object fall, and at once picked it up. It is about the size of a pigeon's egg, broken through the centre; and is partially covered with a black substance. Mr. V. says there is no stone on his farm like it, and is fully persuaded that it is a part of the exploded meteor. Others also think so. It will be examined by competent judges, and the result properly announced."

The above seem conclusively to establish the fact that a meteor of great size passed into our atmosphere on the morning of the 11th of August and exploded with great violence, throwing down stones to the earth. It would even seem possible, from a comparison of these facts, to deduce its mass, velocity and apparent motion.

In this connexion we would recall the familiar history of the remarkable meteor which exploded over Weston, Conn., on the morning of December 14th, 1807, as described by Profs. Silliman and Kingsley.* In that case there were three distinct and violent explosions, each followed by a discharge of meteoric stones, specimens of which from each locality were subsequently obtained. Let us hope that a diligent search for the relics of the Troy meteor will be in like manner rewarded, and the results duly reported.—[D. A. Wells, Esq., of Troy, N. Y., has kindly sent us most of these facts.—Eds.]

Bibliographical Announcements.

5. *Address at the Anniversary Meeting of the Royal Geographical Society* (23d May, 1859); by Sir Roderick Impey Murchison, G.C.St.S., D.C.L., F.R.S., President. London, Cowles & Sons. 8vo, pp. 132.—This Address is full of interesting notices of the lives and services of illustrious members of the Geographical Society deceased during the year.

6. *Elements of Mechanics for the use of Colleges and Academies;* by William G. Peck, Adjunct Professor of Mathematics, Columbia College. New York. A. S. Barnes & Burr. 12mo. pp. 338. 1859.—This work embraces all the important propositions of elementary mechanics, arranged in logical order and each rigidly demonstrated. It fills an important hiatus in our elementary works and in the hands of a good teacher will be highly esteemed.

7. *Annual Report of the Director General of the Geological Survey of the United Kingdom; the Museum of Practical Geology, &c.* 24 pp. 8vo, with 4 progress maps.—This is the annual report showing the progress made in the several important scientific trusts comprised in the Jermyn St. establishment now under the general direction of Sir R. I. Murchison.

8. *Experimental Researches relative to Corroval and Vao; two new varieties of Woorara, the South American Arrow-Poison;* by William A. Hammond, M.D., Assist. Surgeon U. S. Army and S. Weir Mitchell, M.D., Philadelphia. Read before the Academy of Nat. Sci. Philad., May 16, 1859. [*Brochure*, Extracted from the Am. Jour. Med. Sci., July, 1859.] pp. 48.

9. *Astronomical and Meteorological Observations made at the Radcliffe Observatory, Oxford, (Eng.)* in the year 1857, under the superintendence of Manuel J. Johnson, M.A., Radcliffe Observer. Vol. xviii. Published by order of the Radcliffe Trustees. Oxford, J. and J. Parker. 1859. 8vo. pp. 255 Astronomical, 132 Meteorological. 7 plates.

* Memoirs Connecticut Academy of Arts and Sciences, vol. i, pp. 141 (1810.)

10. FOWNES: *A manual of Chemistry, &c.*, edited from the 7th London edition by Dr. ROBERT BRIDGES. Philadelphia, 1859.—The simple announcement of a new edition of this favorite manual is all that is needed to bring it to the notice of students and teachers.

11. *The American Gas Light Journal*, the representative of Light, Water, and Public Health. J. C. Murray & Co., 40 Wall st., N. York. 4to, monthly.

DAVID DALE OWEN: First Report of a Geological Reconnoissance of the Northern Counties of Arkansas, made during 1857 and 1858, by D. D. Owen, Principal Geologist, assisted by W. Elderhoist, Chem. Assistant, and Edward T. Cox, Assistant Geologist. 8vo. pp. 256. *Little Rock*, 1859.

Books in Press.

A Manual of Spherical and Practical Astronomy, embracing Nautical Astronomy, and the theory and use of fixed and portable Astronomical Instruments: amply illustrated by engravings on wood and steel. By Prof. WILLIAM CHAUVENET, of the United States Naval Academy. In two royal octavo volumes. Price $7.50.

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THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. XXXIV.—*The Correlation of Physical, Chemical and Vital Force, and the Conservation of Force in Vital Phenomena;* by JOSEPH LECONTE, Professor of Geol. and Chem. in the South Carolina College, Columbia.

(Read before the American Association for the Advancement of Science, at the Springfield Meeting, August, 1859.)

MATTER constantly changes its *form*—but is itself indestructible except by the same power which called it into being. The same quantity of matter exists in the universe at all times. So also force changes its *form* constantly, but is itself indestructible, incapable of increase or diminution, and the same absolute amount of force exists in the universe at all times and forever. The mutual convertibility of the various forms of force is called "correlation of forces." The invariability of the absolute amount in the midst of constant change is called "conservation of force." This principle of correlation and conservation of force must be looked upon as one of the grandest generalizations in modern science, a principle startling at first, but when clearly understood and firmly grasped, almost axiomatic. It must be considered a necessary truth, and as such is a legitimate basis of deductive reasoning.

The correlation of *physical* forces is universally recognized as a principle in science, and not only so but has already been productive of many beautiful and useful *results;* but the correlation of physical and *vital* forces while generally recognized as a

probable fact has only been speculated on in a vague and as yet unfruitful manner. The science of life is scarcely yet ripe for the legitimate extension of this principle over its domain. The most elaborate attempt of this kind which I have seen, is contained in the very remarkable and suggestive paper of Dr. Carpenter entitled "mutual relation of physical and vital forces," and published in Phil. Trans. for the year 1850.

In the present paper I wish simply to present a few thoughts, which have originated in my own mind, in the course of reflection on this subject, in the hope that they may prove suggestive to others. They have at least the merit of being uninfluenced by the writings of others—and therefore perhaps of presenting the subject in a somewhat new light. I sincerely wish I could present the matter in a more definite form, but it is certain that where a subject is not perfectly understood, the attempt to give our ideas more definiteness also makes them more questionable. We are obliged to be content with a certain vagueness, in the hope that by the use of right methods a clearness will come after. We must gratefully accept the twilight in the hope that it marks the approach of the full light of day.

There are four planes of material existence which may be regarded as being raised one above the other. The *first* and lowest is the plane of elementary existence, the *second* the plane of chemical compounds, or mineral kingdom, *third*, the plane of vegetable existence and *fourth*, of animal existence. Now it is apparently impossible for any known force in nature to raise matter through all these grades at once. On the contrary there is a special force adapted for the elevation of matter from each plane to the plane above. It is the special function of chemical affinity to raise matter from plane No. 1 to No. 2. All the changes too which take place upon plane No. 2 by the mutual reactions of bodies situated on that plane, are under the guidance and control of this force. It is the special prerogative of the force of vegetation—of vegetable life, to lift matter from No. 2 to No. 3, i. e., from the condition of mineral matter to the higher condition of vegetable matter. All the changes which take place upon this plane, the laws of which constitute vegetable physiology, are under the guidance of this force. Finally, the force of animal life and that alone enjoys the privilege of lifting matter still higher into the 4th plane, i. e., the plane of animal existence. No force in nature can lift from No. 1 to No. 3, or from No. 2 to No. 4. Plants cannot feed entirely upon elementary matter, nor can animals feed upon mineral matter. The reason of this will be seen in the sequel. Thus it seems that after matter is raised from the elementary to the mineral condition, it requires an additional force of another and peculiar kind to raise it into the vegetable kingdom, and again another accession of force to raise it into the animal kingdom. These kingdoms are, there-

fore, truly represented as successive planes raised one above the other, thus:

No. 4, *Animal Kingdom.*
3, *Vegetable Kingdom.*
2, *Mineral Kingdom.*
1, *Elements.*

If then it be admitted that this is the relative position of these planes—that it requires a greater and greater expenditure of force to maintain matter upon each successive plane, then it follows *that any amount of matter returning to a lower plane by decomposition must set free or develop a force which may under favorable circumstances raise other matter from a lower to a higher condition.* Or to express it by a mechanical illustration, a given amount of matter falling from one plane to any plane below, develops a force sufficient to raise an equal quantity of matter an equal height. Thus *decomposition* must in every case *develop force*, which force may take the form of heat as in combustion, or electricity as in electrolysis, or may expend itself in forming chemical compounds or *even in organizing matter.*

Again, in the same manner as matter may be arranged in several distinct and graduated kingdoms, so it seems to me the forces of nature may also be properly divided into distinct groups arranged in a similar manner one above the other. These are the *physical*, the *chemical* and the *vital* forces. And as in the case of matter so also in the case of *force*, it is impossible to pass directly from the lowest to the highest group without passing through the intermediate group. The conversion of *physical* into *vital* force seems impossible without passing through the intermediate condition of *chemical force.*

These are the simple principles upon which are based all that follows—principles which may possibly seem fanciful to some unfamiliar with the principle of conservation of force, but the number of phenomena which they consistently explain will I hope entitle them to serious thought.

1st. It is well known that chemical elements, in what is called the "nascent condition" i. e., at the moment of liberation from previous combination, exhibit a peculiar energy of chemical affinity not exhibited under other circumstances. It seems to me that this is readily explicable on the principle of conservation of force. At the moment of decomposition the chemical affinity which bound the elements together and which was before satisfied, is suddenly left unsatisfied. There is an attraction *set free* which was before *disguised*—a force *liberated* which was before *latent.* If conditions favorable are present this force may preserve the form of chemical affinity, and expend itself in forming other chemical compounds; or even, as we shall see hereafter, in organizing matter. But if favorable conditions are not

present, then it may take some other form of force, e. g., heat or electricity, and *therefore no longer exist as chemical affinity*. The chemical affinity is said to be lost. To return to the mechanical illustration used above. Matter falling from plane No. 2 to plane No. 1 develops force sufficient to raise *other matter* from plane No. 1 to No. 2, but which in the absence of such matter may expend itself in heat or electricity or some other form of physical force.

2nd. It is a fact, now well established, that the *seed* in germination forms carbonic acid, and in doing so loses weight. That is, the organized matter of the seed is *partially decomposed*, a portion of its carbon uniting with the oxygen of the air to form carbonic acid. Now it is this *decomposition* which develops the force by which germination is effected. A portion of the organic matter of the seed is *decomposed*. This decomposition sets free a force which suffices to organize the rest. The force necessary and therefore the amount of decomposition necessary in this case is small because the work to be accomplished is simply the change from one form of organic matter to another, or rather from *organic* to *organized* matter—to recur again to the former illustration, merely shifting a certain quantity of matter from one place to another upon the plane No. 3. "But how," it may be asked, "is this decomposition brought about?" This seems to be effected by the heat and perhaps (according to Hunt) by the actinic rays of the sun.* Heat and actinic rays have been spoken of by many writers, e. g., by Carpenter and by Robert Hunt as the physical force which is changed into organizing force by means of the "substratum of an organized structure:" but the peculiarity of the view which I now present, is that this conversion does not take place *immediately*, but only *through the mediation of another force more nearly allied to the vital*, viz: *chemical force*. The food is laid up in the seed mostly in the form of starch. In the act of germination this starch is changed into sugar. Starch as is well known differs from sugar in two important respects, viz., it is *insoluble* and it is more *highly carbonized*.† Now according to the ordinary view, the only object of the partial decomposition is to change the food from an insoluble to a soluble form—and this can be done only by elimination of a portion of the carbon in the form of carbonic acid. According to the view which I now present, *the food is always laid up in a more highly carbonized condition than is wanted, in order that force may be set free by elimination of superfluous carbon*. According to the ordinary view, if an insoluble food could be found, capable of conversion into the soluble form, without loss of car-

* See Report by Robert Hunt on the growth of Plants, Rep. Brit. Assoc., 1846, p. 83, 1847, p. 30.

† Robert Hunt, Rep. Brit. Ass., 1847, p. 20–22. Carpenter, Comp. Phys., p. 288. Mülder, Chem. An. and Veg. Phys., pp. 208, 230.

bon; then germination of the seed might take place without loss of weight, by the direct conversion of heat into vital force. According to my view, *decomposition* and therefore *loss of weight, is absolutely necessary to develop the organizing force*, the loss of weight being in fact the exact measure of that force.

3rd. As soon as the plant develops *green leaves*, a complete change takes place in its mode of development. It no longer loses weight but increases in weight. It not only develops but *grows*. The reason of this is, that the organizing force is no longer developed by decomposition of food laid up within its own tissues, but by the decomposition of food taken *ab externo*. Sunlight is universally admitted to be the physical force concerned in this decomposition. Farther, it is generally supposed that there is a direct and immediate conversion of light into vital force in the green leaves of plants. But evidently this is impossible, since the *work done by the light is the separation of the two elements carbon and oxygen*. Light is therefore converted into *motion*. It is therefore the chemical affinity thus set free which is the force immediately converted into vital force. The food of plants consists of carbonic acid, water and ammonia (CO_2, HO and NH_3,) or in some cases according to M. Ville of CO_2, HO and N.* Sunlight acting through the medium of the green leaves of plants has the remarkable power of decomposing CO_2. The *force thus set free from a latent condition*, or the chemical affinity of *carbon in a nascent condition* is the force by means of which C, H, O and N are raised to the organic condition.† To return to my former illustration; matter (oxygen) falling from the second to the first plane develops force sufficient to raise other matter from the second to the third plane. Thus it is evidently *impossible on the principle of conservation of force that plants should feed entirely upon elementary matter;* whereas according to the ordinary view of the direct conversion of light into organizing force, there is no reason why plants should not feed entirely on elements, except that one of them, carbon, is insoluble.

4th. There are many other phenomena of vegetable life which receive a ready explanation on this theory. I have said that sunlight has the power of decomposing carbonic acid only in the *green* leaves of plants. *Pale plants*, such as the Fungi among cryptogams and the Monotropa among phænogams, have no power to decompose CO_2. These plants, therefore, cannot feed

* See review of the controversy between Boussingault and Ville on this subject, Bib. Univ. Arch. des Sci., vol. 30, p. 305. Also Phil. Mag., 4th ser., vol. 13, p. 497. Ann. des Sci., 4th series, vol. 2, p. 357. Am. Jour. Science, vol. 19, p. 409. Bib. Univ. Arch. des Sci., vol. 28, p. 335. Ann. des Sci., 4th series, vol. 7, p. 5.

† Ammonia is also probably decomposed in the tissues of the leaves of plants, (Carpenter, correlation of physical and vital forces, Phil Trans., 1850, p. 732. See also Morren, Bib. Univ. Arch. des Sci., new period, vol. 5, p. 84). This would of course produce additional organizing force.

upon chemical compounds—mineral matter. They *must feed upon organic matter*, which organic matter *in its partial decomposition furnishes the force necessary for organization.* If so, then this decomposition, as in the case of germination, must be attended with the elimination of CO_2. Both of these are known to be facts. Pale plants do feed upon organic matter and do evolve CO_2. The necessary connection of these facts with one another and with the principle of conservation of force, is now for the first time, as far as I know, brought out. The phenomena of nutrition in these plants is similar to that of seeds in germination, except that the latter contains the organic matter already laid up within its own tissues, while the former derives it from decaying vegetable or animal matter taken *ab externo* into its tissues. In this case too, as in germination, heat is apparently the physical force which effects the decomposition of the organic food, and which is therefore converted indirectly through chemical into vital force. Light is actually unfavorable to this process, for light tends to decompose, not to form CO_2. In both cases therefore the conditions favorable for nutrition are first, abundance of soluble organic matter, second, absence of light and presence of heat. This is then apparently the true reason why germinating plants and pale plants avoid the light. These plants grow by the *oxydation* of carbon and formation of CO_2. Light *decomposes* CO_2 and must therefore be antagonistic to its formation, and consequently to the growth of these plants. Whether or not this property of light is entirely limited by the condition of its acting through an organic tissue, is a question yet undetermined. Heat we know is favorable to the oxydation of carbon (combustion, fermentation, putrefaction, &c.,) under all circumstances. Has light an opposite property also under all circumstances, or is this opposite property of light limited to the condition of its acting through the medium of an organism? I hope the experiments already commenced and still in progress, by my brother Prof. John LeConte, and published in the last proceedings and in the American Journal of Science and Arts, vol. 24, p. 317, will eventually furnish the means of solving this very important problem. I do not wish to anticipate the final results of these experiments, but it seems to me that the negative results thus far obtained, rather support the view that the action of light is not thus limited. In all experiments on this subject the light and heat of the sun have been combined. Now heat we know is favorable to combustion. The fact then that combined light and heat produced no effect, would seem to indicate that light counteracted the effect of the heat of the sun.

5th. *Etiolated plants*, or plants artificially blanched by exclusion of light, exhibit the same phenomena and for the same reason. These plants cannot receive their organizing force

through the decomposition of CO_2 by sunlight: therefore they are obliged to obtain it from decomposition of organic matter. Hence these plants require organic food, hence also they evolve CO_2 instead of oxygen. In this case also decomposition of organic matter, with a separation of a portion of the carbon in the form of CO_2, furnishes the organizing force. In the absence of any external organic matter in the form of humus or manure, etiolated plants like germinating seeds will feed for awhile upon organic matter previously accumulated in their tissues in the form of starch and actually *lose weight* of solid matter.*

6th. In a most interesting and suggestive article in the Bibliothèque Universelle (Archive des Sciences,†) on the subject of humus, M. Risler shows in the most conclusive manner that organic matter in a soluble condition (soluble humus) is taken up by *almost all plants*. This fact had been previously proved experimentally by Th. de Saussure, but having been denied by Liebig, it has been very generally neglected by vegetable physiologists. The doctrine of Liebig and of physiologists generally, is that, except in case of pale plants, organic matter is decomposed into CO_2, HO and NH_3, i. e., must fall into the mineral kingdom before it can be absorbed and assimilated by plants, and therefore that organic manures only supply the same substances, and in exactly the same form, which are already supplied, but in insufficient quantities, by the atmosphere. But M. Risler repeats with great care the experiments of de Saussure, and confirms the accuracy of his conclusions. Hyacinths and other bulbs were placed with their roots suspended in water colored with soluble extract of humus. When these plants were placed in the sun, the water became rapidly decolorized. Other roots such as carrots, also germinating grains of wheat, were observed to produce the same effects. An extract of humus was exposed at a somewhat elevated temperature to sunlight under a bell glass. Microscopic plants developed in great abundance. As long as these plants continued to develop the infusion was transparent and did not putrefy in the slightest degree: and yet there was a constant evolution of CO_2 as shown by analysis of the air in the bell-glass. "Now the cellules formed in the liquid contained carbon. This carbon did not come from the CO_2 of the air, for the liquid, far from *absorbing*, disengaged CO_2. Therefore the soluble humus must have furnished the carbon *directly* to the vegetable cells." It could not have furnished it *indirectly* in the form of CO_2 derived from decomposition of the organic matter, otherwise *oxygen* instead of CO_2 would have been eliminated. M. Risler thinks moreover that the *embryo* in germination takes up soluble organic matter in the form of humus in

* Carpenter, Comp. Phys., p. 285.
† Bib. Un. Arch. des Sci., new period, vol. 1, p. 305.

addition to the soluble organic matter contained within the cotyledons, and that the evolution of CO_2 by germinating seeds is due in part also to the oxydation of humus. Finally, according to the same author, the formation of roots in all plants, but particularly those containing much starch or sugar, is due to the direct absorption of humus, and not, as is generally supposed, by the fixation of carbon by means of light. "In order" says he "that CO_2 of the air should form these substances, it is necessary, in the beet and the potatoe, that there should be a descending sap, which there is not." Moreover if the carbon was taken from the soil in the form of CO_2 there should be elimination of oxygen instead of evolution of CO_2; but the converse is the fact as has been proved in the most indisputable manner by de Saussure and Boussingault.*

Mülder is equally explicit in affirming that plants absorb soluble organic matter which is converted in the roots, by elimination of a portion of the carbon, into starch and sugar.—Mülder, pp. 620, 664, 682. Thus according to these authors, *sap is actually elaborated by the roots* from organic manures.

Now according to the theory which I propose, *this change from humus into starch, sugar or cellulose, furnishes an additional life-force.* Humus is a more highly carbonized substance than either starch or cellulose. By the *partial decomposition of humus* in the tissues of the plant, with the elimination of a portion of its carbon (removed by oxydation) *a chemical force is set free which serves to assimilate the remainder.* Hence, this process of evolution of CO_2 as we have already said, is opposed by light but favored by darkness and heat. Light favors the formation of chlorophyll, of woody fibre, of essential oils, gums, &c.; darkness, heat and organic manures, favor the formation of sugar, starch, &c. Hence the explanation of the well known fact that by covering up the lower portions of potatoe plants by heaping earth around them, many buds which would otherwise form leafy *branches* develop into *tubers*. Hence also the explanation of the equally well known fact that the roots of plants seek and grow most rapidly in the direction of most abundant food. If the sap is elaborated entirely in the leaves, it is difficult to understand why the descending sap should flow in greater abundance in one direction than another. But if sap is elaborated in *the root itself* it is easy to see why growth is most rapid in the direction of most abundant manure. It is easy to see, too, why roots avoid the light; since light decomposes CO_2 and therefore must be unfavorable to the formation of this substance.

7th. It is a well known fact that the so-called *respiration of plants* consists of two distinct and apparently opposite processes, 1st, the absorption of CO_2 by the leaves and also in solution by

* Bib. Un. Arch. des Sciences, new series, vol. 1, p. 5.

the roots, the decomposition of this CO_2 by means of light with the fixation of the carbon and the elimination of the oxygen: 2nd, the recomposition and evolution of Co_2. The *decomposition* of CO_2 undoubtedly takes place in the leaves, but where the recomposition of CO_2 takes place is not so well ascertained. It is exhaled however, like the oxygen, from the leaves. The process of decomposition of CO_2 takes place only during the day as light is absolutely necessary for this process. The *recomposition* of CO_2 takes place night and day, although its exhalation according to some observers seems to be more abundant during the night. The process of decomposition of CO_2 is well understood—of that of recomposition our knowledge is very imperfect. M. Risler's explanation of this latter process seems most probable. Plants, we have seen, undoubtedly absorb soluble organic matter, i. e., humus. Humus we know is a more highly carbonized substance than cellulose or starch. This humus is therefore oxydized in the roots and interior of the trunk, away from light, by means of oxygen also absorbed by the roots and thus forms CO_2. This CO_2 then circulates in the sap to be exhaled by the leaves or perhaps to be again decomposed by sunlight in this organ. In the absence of light the whole is exhaled undecomposed. This readily accounts for the apparently greater exhalation of CO_2 during the night. A series of well conducted experiments would test the truth of this view. If it is true, there should be a relation between the richness of the soil in organic manures and the amount of CO_2 exhaled. For a given amount of growth, the amount of CO_2 exhaled is the measure of the amount of food taken up in the form of organic matter, and the amount of oxygen exhaled is the measure of the amount of food taken in the form of mineral matter. Or if the exhaled CO_2 is decomposed in the leaves during the day, then of course the difference between the amount exhaled during the night and day would enter as an element in the calculation. Also it would seem that those plants, especially, which frequent rich shady spots, should exhale proportionally more CO_2 and less oxygen, than those loving thin soils and sunny places.

In plants then, there are *two sources of organizing force*, the relative proportion of which varies infinitely, according to the amount of light, heat, color of the plant and richness of the soil in organic matters. The two sources are *immediately*, 1st, the decomposition of CO_2, 2nd, the decomposition of soluble highly carbonized organic matter: *remotely* the two sources are *light* and *heat*. In plants which first take possession of desert spots, bare rocks, &c., the *first* is the only source. In pale plants and fungi the *second* is the only source; but in most plants the two are combined in various proportions. The 1st must of course be considered the most fundamental and necessary, the 2nd being

evidently supplementary. The decomposition of CO_2 by sunlight may be considered as the original source of all vegetation, but in most of the higher orders of plants the process of nutrition is expedited by the reabsorption of organic matter before it again returns to the condition of CO_2, HO and NH_3.

8th. The *egg* during incubation, absorbs oxygen, evolves CO_2, and probably HO, and loses weight. As the result of this evolution of CO_2 we find the egg *develops.* What it *loses in weight* it *gains in organization.* Now what is the source of the organizing force? It evidently bears a direct relation to the loss of weight. Here also, then, we have *partial decomposition furnishing the necessary force.* A portion of the organic matter, falling from the organic to the mineral plane, sets free a force which raises the remaining portion into a slightly higher condition. Heat is evidently the physical force or agent which is transformed, not directly but *indirectly, through chemical affinity,* into vital force. In other words, heat is the agent which effects the necessary decomposition. The phenomena of development of the egg is, therefore, very similar to that of the seed.

9th. *After the hatching* of the egg, the animal no longer loses weight; because recomposition of food taken *ab externo* proceeds *pari passu* with decomposition. But in this case also *decomposition supplies the force by which recomposition is effected,* and growth and development carried on. As this is an important point I will attempt to explain it more fully.

It is well known that in the animal body there are, going on constantly, two distinct and apparently opposite processes, viz., decomposition and recomposition of the tissues; and that the energy of the life is exactly in proportion to the rapidity of these processes. Now according to the ordinary view, the animal body must be looked upon as the scene of continual strife between antagonistic forces chemical and vital; the former constantly tearing down and destroying, the latter as constantly building up and repairing the breach. In this unnatural warfare the chemical forces are constantly victorious, so that the vital forces are driven to the necessity of contenting themselves with the simple work of reparation. As cell after cell is destroyed by chemical forces, others are put in their place by vital forces, until finally the vital forces give up the unequal contest and death is the result. I do not know if this view is held by the best scientific minds at the present day, as a fact, but it certainly is generally regarded as the most convenient method of representing all the phenomena of animal life, and as such has passed into the best literature of the age. Certain it is however that the usual belief, even among the best physiologists, is that the animal tissue is in a state of unstable equilibrium; that constant decomposition is the result of this instability, and that this *decomposition and*

this alone, creates the necessity of recomposition—in other words creates the necessity of food. But according to the view which I now propose, decomposition is *necessary to develop the force* by which organization of food or nutrition is effected, and by which the various purely animal functions of the body are carried on—that decomposition not only creates the *necessity* but at the same time furnishes the *force* of recomposition.

But it will no doubt be objected that according to the principle of conservation of force, decomposition of a given amount of matter can only effect the recomposition of an equal amount—that a given quantity of matter falling a given height, can only raise an equal quantity an equal height: the whole force developed by decomposition seems to be expended in maintaining the body at a given position. How then can *growth* and *animal activity* go on? The answer to this question is obvious enough when we recollect the nature of the food of animals. Animals it is well known cannot feed upon mineral matter but only on food already organized, at least up to the vegetable condition. But when decomposition takes place, the animal matter returns no longer to the vegetable condition from which it was immediately raised, but to the mineral condition. It is decomposed into CO_2 HO and *urea*. This last substance though not strictly a mineral substance is far below the condition of vegetable matter. Thus it is evident that *a given quantity of matter falling down from the condition of animal to that of mineral matter*, i. e., from the 4th to the 2nd plane, *would develop force sufficient to lift a larger quantity of matter from the vegetable to the animal condition*, i. e., from the 3rd to the 4th plane, and yet perhaps leave much residual force unexpended. Thus it is possible, and not only possible but certain, on the principle of conservation of force that decomposition of animal tissues should set free, a force, a part of which is consumed in the recomposition of a *larger* amount of new matter and thus maintaining growth; a part in animal heat and a part in animal activity of all sorts. In this view of the case we see at once the absolute necessity that the food of animals should be organized. Upon the principle of conservation of force, growth and animal activity, in a word, animal life, would otherwise be impossible.

It follows also from the above, that the higher the organization of the food the smaller the amount of force necessary to effect assimilation, and therefore the larger the amount of residual force to be expended in animal heat and animal activity. In this we find a ready explanation of the superior activity of *carnivorous* animals, and the loss of animal activity which results in a state of domestication from the use of vegetable diet; also of the supposed superior activity of men fed upon meat diet.

10th. I have spoken thus far of only one source of vital force in animals, viz., the *decomposition of the tissues.* I have attempted to show how, upon the principle of conservation of force, this is sufficient to carry on the growth and the activity of the animal organism. But decomposition of the tissues, though the fundamental source—the source characteristic of and peculiar to animals—of immediate and universal necessity in this kingdom, and in many cases sufficient of itself, is not the only source. There is also in animals as in plants a supplemental source, viz., *the decomposition of food.*

It is well known that the food of animals consists of two kinds, the nitrogenous, such as albumen, fibrin, casein, &c., and the non-nitrogenous, such as fat, starch, sugar, gum, &c. According to all physiologists since Liebig, the nitrogenous alone are used in the repair and growth of the tissues. The non-nitrogenous are either quickly consumed in respiration, or else are laid up in the form of fat for future consumption in the same way. Now there can be no doubt that animals may live entirely on nitrogenous food; in which case the whole vital force, whether for assimilation of food or for animal heat and animal activity, is derived from the decomposition of the tissues. This is the case also, apparently, in the starving animal, particularly if lean. But in almost all cases much food in the form of fat, starch, sugar, &c. (non-nitrogenous), is never transformed at all into tissues, but is taken into the blood, gradually decomposed, oxydized in the course of the circulation, changed into CO_2 and HO, and finally removed by exhalation from the lungs. Now what is the object of the non-nitrogenous food, since these do not form any part of the tissues but are again decomposed and thrown out of the system? The answer usually given is that such food is used in the animal economy solely as fuel to keep up the animal heat. On this view it is difficult to see why this class of food should be used at all, especially in warm climates. But according to the view which I propose we have here an *additional source of vital force.* The decomposition of these ternary compounds sets free a force which is used in organizing and assimilating other matter (nitrogenous) and in producing animal activity and animal heat. As in plants, although the decomposition of CO_2 by sunlight is all that is absolutely necessary for growth and development, yet the decomposition of organic food supplies an additional force which greatly increases the vigor and rapidity of vegetation; so in animals, although *decomposition of the tissues* is all that is absolutely necessary to furnish the force of growth and the phenomena of animal life generally, yet the decomposition of non-nitrogenous organic *food* furnishes additional force by which growth and animal activity may be maintained without too great expenditure of the tissues.

11th. In what then consists the essential difference between animals and plants? There can be no doubt that it consists, generally, in their relations to one another and to the mineral kingdom. Plants occupy a middle ground between the mineral and animal kingdom—a necessary halting place for matter in its upward struggles. But when we attempt to define this relation more accurately, the problem becomes much more difficult. It is indeed probable that no single distinction will be found free from objection. The commonly received and, to a certain extent, very correct idea is, that the essential distinction consists in their relation to CO_2. Plants *de*compose and animals *re*compose CO_2. The beautiful manner in which the two kingdoms stand related to each other through these converse processes, is familiar to all. But it is well known that most plants carry on both of these processes at the same time, while some, as fungi, pale plants, &c., only recompose CO_2 like animals. It seems to me that at least an equally good fundamental distinction may be found in this, that in plants the fundamental and necessary source of vital force is the decomposition of its *mineral food;* while in animals the fundamental source of vital force is the decomposition of its *tissues.* It is true that in what I have called the supplementary source of vital force they seem to meet on common ground, viz., the decomposition of *organic food;* but even here there is this essential difference, that in plants this decomposition of organic food is only partial, and therefore furnishes not only *force* but *material* for organization; while in animals the decomposition is complete and therefore furnishes only *force.*

As a necessary result of the above, it would seem that the "*vortex*" of Cuvier is characteristic of animals. There seems no reason to believe that a tissue once formed in plants is ever decomposed and regenerated, as is the case in animals. When plant-cells decompose, the tissue dies. Hence the absolute necessity of *continuous growth* in plants. In this kingdom *life* is synonymous with growth. There is no possibility of life without growth. There is no such thing as determinate size, shape, or duration. There is no such thing as maturity, or if so, death takes place at the same instant. As cell life is necessarily of short duration, and as there is no regeneration of tissues in plants, it is evident that the life of the tissues must be equally short. Thus plant life can only be maintained by the continual formation of *new tissue* and a constant travelling of the vital force from the old to the new. In exogenous plants the direction of travel is from the interior to the exterior; in endogens from exterior to interior, and still more from below upwards by the continual addition of new matter at the apex. In fungi where there is no such superposition of new tissue upon the old, where

growth takes place by multiplication of cells throughout the whole plant—in other words, a true interstitial growth as in animals—since there is no regeneration of tissues, the duration of the life of the plant is limited by the duration of cell-life.

The *respiration* of animals, also, differs essentially from that of plants. At one time the absorption of CO_2 and exhalation of O was called the respiration of plants. It is universally admitted now, however, that this is rather a process of assimilation than of respiration. The recomposition and exhalation of CO_2, as soon as discovered, was very naturally likened to animal respiration, and is in fact looked upon by many, as for example the physiologist Carpenter, as a true respiration. But there is an essential difference between this and animal respiration, which I have already pointed out. Its very significance is radically different. The essential object of animal respiration is the removal of poisonous decomposed matters from the organism. The so-called respiration of plants, on the contrary, is rather a process of assimilation, since by it the too highly carbonized organic food, by the elimination of a portion of its carbon, is brought into a proper condition for organization. A true respiration is necessarily connected with a change of the matter of the tissues—with the vortex of Cuvier—which has never been shown to exist in plants. It is true the exhalation of CO_2 has been looked upon by some physiologists as indicative of a regeneration of tissues, but I have already shown that this is probably not the case, but on the contrary that the CO_2 is formed by the partial decomposition of highly carbonized organic *food*.

12th. The most natural condition of matter is evidently that of chemical compounds, i. e., the mineral kingdom. Matter separated from *force* would exist, of course, only as elementary matter or on the *first plane;* but united with force, it is thereby raised into the *second plane* and continues to exist most naturally there. The *third plane* is supplied from the second, and the fourth from the third. Thus it is evident that the quantity of matter is greatest on the second and least on the fourth plane. Thus nature may be likened to a pyramid, of which the mineral kingdom forms the base and the animal kingdom the apex. The absolute necessity of this arrangement on the principle of the conservation of force may be thus expressed. *Matter*, *force* and *energy* are related to one another in physical and organic science somewhat in the same manner as *matter*, *velocity* and *momentum* in mechanics. The whole *energy* remaining constant, the greater the *intensity* of the force (the elevation in the scale of existence) the less the quantity of matter. Thus necessarily results what I have called the pyramid of nature, upon which organic forces work *upwards* and physical and chemical forces *downwards*.

13th. As the matter of organisms is not created by them, but is only so much matter withdrawn, borrowed as it were, from the common fund of matter, to be restored at death; so also organic forces cannot be *created* by organisms, but must be regarded as so much force abstracted from the common fund of *force*, to be again restored, the whole of it, at death.* If then vital force is only transformed physical force, is it not possible, it will be asked, that physical forces may generate organisms *de novo?* Do not the views presented above support the doctrines of "equivocal generation" and of the original creation of species by physical forces? I answer that the question of the origination of species is left exactly where it was found and where it must always remain, viz., utterly beyond the limits of human science. But although we can never hope by the light of science to know *how* organisms originated, still all that we do know of the laws of the organic and inorganic world seem to negative the idea that physical or chemical forces acting upon inorganic matter can produce them. Vital force is transformed physical force, true, but the necessary *medium* of this transformation is an organized fabric; the necessary condition of the existence of vital force is therefore the previous existence of an organism. As the existence of physical forces cannot even be conceived without the previous existence of matter as its necessary *substratum*, so the existence of vital force is inconceivable without the previous existence of an organized structure as its necessary substratum. In the words of Dr. Carpenter, "It is the speciality of the material substratum thus furnishing the medium or instrument of the metamorphosis which establishes and must ever maintain a well marked boundary line between physical and vital forces. Starting with the abstract notion of force as emanating at once from the Divine will; we might say that this force operating through inorganic matter, manifests itself as electricity, magnetism, light, heat, chemical affinity and mechanical motion; but that when directed through organized structures, it effects the operations of growth, development and chemico-vital transformations."

* Carpenter, Phil. Trans., 1850, p. 755.

ART. XXXV.—*Report on the Exploration of two Passes, (the Kootanie and Boundary Passes) of the Rocky Mountains in* 1858; by Captain BLAKISTON, Royal Artillery. (With a map.)*

[WE have been favored by General Sabine through Dr. A. D. Bache with an early copy of Captain Blakiston's Report, which with its accompanying map we take pleasure in bringing before our readers. Capt. B. was detached from his position as Magnetician to the expedition of Capt. J. Palliser for exploring British N. America, for the purpose of taking command of the party whose adventures and discoveries he records. The Victoria Gold Metal of the Royal Geographical Society has just been awarded to Captain Palliser for the successful results of his exploration of large tracts in British North America, and more particularly for the determination of the existence of these practical passes across the Rocky Mountains within the British Territories.

The interest of Capt. Blakiston's Report will not be diminished by the appendix we add to it from Sir R. I. Murchison's anniversary address, detailing some of the results of the Palliser Expedition.—EDS.]

On the 12th of August, 1858, I left the camp of the main body of the Exploring Expedition at the site of Bow Fort, base of the Rocky Mountains, lat. 51° 9′ N., long. 115° 20′ W., and after crossing the Bow River by a ford about four miles above that point, I gained ground to the eastward, so as to get clear of the broken and wooded country on the edge of the mountains.

My party consisted of three Red River half-breed voyageurs, Thomas Sinclair, Amable Hogg, and Charles Racette, besides a

* To H. MERIVALE, Esq., *Under Secretary of State for the Colonies.*

18, Ashley Place, April 18, 1859.

SIR,—I have the honor to enclose a Report which I have received by post from Captain Blakiston of the Royal Artillery, with a request that it should be transmitted for the information of H. M. Government.

The Report, with Map and Sections, states the particulars of Captain Blakiston's Explorations of the Kootanie and Boundary Passes of the Rocky Mountains; the first known only by name, and the second unknown, except to the native Indians; the Kootanie Pass proving to be the most southern, and by far the shortest yet known in the British territory.

I have at the same time received from Captain Blakiston a continuation of the magnetic observations which constituted his special duty, up to the date of the transmission of his letter. These evince the same care and skill which have characterized his former observations. The results will be laid before the Royal Society, as those of his earlier observations have been.

In the successful conduct of the exploration confided to him by Mr. Palliser, Captain Blakiston has had an opportunity of manifesting his desire and capability of contributing towards the accomplishment of the Geographical objects of the expedition, which will, I trust, obtain for him the approval of H. M. Government.

(Signed) EDWARD SABINE, Major-General, R. A.

Thickwood Cree Indian "James," whom I had engaged as hunter to the party. I had ten horses, five of which were used for riding, and the rest carried the packs, containing a quantity of ball and powder, tobacco, a few knives, and other articles of small value for Indian trade; also some dried meat and pemmican, with tea, sugar and salt, as well as two boxes containing my instruments, books, &c.

Soon after leaving Bow River, we crossed one of its tributaries, the Kananaskasis or Lake River, a rapid stream coming out of the mountains from the southwest; here we saw the remains of many wooden carts, which had been abandoned by a party of emigrants from Red River Settlement, under the late Mr. James Sinclair, on their way to the Columbia, in 1854, who had found it impossible to drag them further into the mountains. This pass, I believe, follows the course of the river to its source, and is the one by which Sir George Simpson governor of the territories of the Hudson's Bay Company, as well as another party of emigrants crossed the Rocky Mountains in 1841. In the past season it was travelled by Capt. Palliser.

The forest consists of spruce (*Abies alba*), a small pine (*P. Banksiana*), and another rough-looking *Abies* which grows to a large size, also a few balsam poplar, and aspen. In travelling through these mountain forests, the greatest obstruction is the fallen timber, which lying about in all directions, causes much exertion to the horses, and confines them to a slow pace. During this first day's travel I noticed the devastating effects of a tempest; numbers of trees had been blown down, and many broken short off. The work of destruction had evidently been of this year, but there were also signs of former work of the same character.

The following day, our course still tending a good deal to the eastward, carried us farther and farther from the mountains, but we passed within twelve miles of a marked outlier, which from its peculiar form, I called "The Family." After this as we travelled along through a partially wooded country, and receding from the near hills which obstructed the view, a sharp peak entirely covered with snow, opened to us at about forty miles distance. The wind was from the westward, and to the east of the summit of the peak rested a mass of white cloud, which was very marked, for there were no other clouds to be seen, with the exception of a few light cirri over head. This attending cloud gave the mountain the appearance of an active volcano, and the effect against the clear sky was extremely beautiful. The phenomenon was caused by the aqueous vapor of the warm Pacific breeze, being condensed by the coldness of the snow, and appearing as a cloud to the leeward of the peak. I took careful

bearings of this mountain, to which I gave the name of "The Pyramid."

We camped at the forks of a creek, called by our hunter the "Strong Current." Here he was successful enough to procure a few fine mountain trout, which proved a very agreeable change to our ordinary fare, which consisted of dried buffalo meat, containing by no means too large a proportion of fat, washed down by tea. Bread was not in our bill of fare, and I may here state, that during the whole summer while travelling, with the exception of two Sundays, I never tasted a morsel of farinaceous food. This may appear astonishing, but when continually travelling, with the appetite sharpened by a ride over the prairie in the cool breeze of the mountains, one becomes accustomed to do without flour, salt, sugar, &c., which under other circumstances would be considered indispensable.

The next day was Saturday; we rose early, packed the horses, and made a start as usual about sunrise, and travelled on through much the same sort of country, the up-lands being generally wooded, while the bottoms were partially covered by scrub-willow and other bushes. We halted between 8 and 9 A. M. for breakfast, giving the horses a "spell" of a couple of hours or so; then started again, and gained a somewhat elevated position, from which we had an extensive view of a fine valley, watered by two clear mountain streams, which as they neared the edge of the great plains, stretching probably without break for 700 miles eastward, united, and with mingled waters, pursued their course towards Bow River, ultimately to pour themselves into the icy basin of Hudson's Bay. We continued on until we reached the southernmost of the two creeks, within ten yards of which, under the shade of some fine poplars, I pitched my small patrol tent. The valley bottom was a fine piece of prairie pasture for the horses, and presented a most suitable resting-place for a Sunday camp. I had (for it was only two o'clock), halted in sufficient time to allow me to obtain an observation of the sun during the afternoon for comparison with one I hoped to obtain on the morrow, and so rate my chronometer. This important instrument was carried each day, turn about, by one of the men, who for that day did nothing else but carry it as carefully as possible. I would recommend this plan to future explorers. In a large party, a few of the steadier hands should be selected for this service; but the same man should never be obliged to carry the instrument every day, lest he become careless.

My ordinary mode of travelling, gave the horses six to seven hours' work per day, with the exception of Sundays. Frequently I halted from breakfast till noon, in order to obtain an observation for latitude, in which case I camped later. I never, however, gave up the plan which I adopted from the first, of making

an early start, and getting the best part of the day's work over before noon. There are many reasons in favor of it. The horses were mostly Indian ponies, which are hardy and work well on grass. They grow somewhat lean while living out during the severe winter weather, but fatten rapidly with the appearance of the new grass in the spring. They are not accustomed to shoes, but I had some on three of them, whose feet I considered too much worn down for the rocky ground of the mountains. On camping, the horses after being watered, are left to themselves for the night, the fore legs of those likely to wander being hobbled with a piece of soft leather. They are very sagacious in following a trail. The 15th of August was a Sunday. While continually travelling, it will be found that rest one day in seven is required by man and horse, the former taking advantage of it to wash and mend clothes.

The weather continued fine, and this day the thermometer rose to 85° in the shade, with a clear sky, and fresh breeze off the mountains in the afternoon, the day closing with a calm evening. This mountain breeze appears to be a regular occurrence during the fine summer weather of this season. On each of three successive days of fine weather which we enjoyed at the site of Bow Fort, the morning was calm, at about 7½ A. M., the wind commenced lightly from about W.S.W. off the mountains, and gradually increasing in the middle of the day and afternoon it blew a fresh breeze from the same point, with usually some *cumuli* over the mountains, which disappeared before reaching the plains; in the evening the wind fell, and the night was calm. The explanation of this phenomenon is the same as that of the sea breeze so unvarying in tropical islands, namely, that as the sun gains altitude, the great plains which are entirely prairie become heated, and consequently, the air in contact with them ascends and is replaced by the cooler air from the mountains.

Our general course for the next three days was a point east of south, for we were now as far out from the mountains as our Indian thought requisite. We were, however, within the outlying ridges, which are numerous, and all run parallel to the larger ranges of the great chain, namely, S.S.E. Thus travelling the course we were on, we had very seldom to surmount any high land, but passed along the valleys between these ridges.

The country was less wooded than that previously passed, being for a considerable part, fine prairie slopes. The main range or watershed, as I supposed it to be, was occasionally visible, through gaps in the nearer mountains, at a distance of about thirty miles.

On the 16th our hunter was lucky enough to procure us some fresh meat in the shape of a wupite or wa-waskasew (red deer)

of the Crees. In order to lighten the burthen of the horses and preserve the meat, the bones were taken out, and it was cut into thin flakes and half-dried over the night camp fire.

The same afternoon, as we arrived at Trap Creek, just above its junction with High Woods River, we found six tents of Thickwood Stone Indians who were just preparing their encampment. We camped along with them, and as usual, when with or near any Indians, my flag, a St. George's Jack, was hoisted on a pole in front of the tent. I gave them a present of some tobacco and fresh meat. These Stone Indians, with whom are associated also a few Crees, and whose hunting ground is the wooded and semi-wooded country along the base of the mountains, like the head-natives of the Saskatchawan, are a harmless and well disposed people towards the whites. Education has, thanks to the former Wesleyan missionary, the Rev. Mr. Rendall, and his successor the Rev. Thomas Wolsey, made some little progress amongst them; a few being able to read and write the Cree syllabic characters, now in general use among the missions of the northwest.

During the afternoon I held a talk with these Indians. I told them plainly for what reason we had been sent to the country; that Her Majesty was always glad to hear of their welfare, and that any message which they might have for her, I would take down in writing.

"We are glad," said an old man, "that the great woman chief of the whites takes compassion upon us, we think she is ignorant of the way in which the traders treat us; they give us very little goods and ammunition for our furs and skins, and if this continues our children cannot live. We are poor, but we work well for the whites. The Indians of the plains treat us badly and steal our horses, but we do nothing to them, for the minister tells us so." In answer to questions from myself, they said that they would wish white people to come and live among them, and teach them to farm, make clothes, &c., so that "their children might live," for the animals are getting every year more scarce. I may here state, that I have been fortunate enough this year to fall in with many camps of the different tribes of Indians inhabiting this country, from whom I always obtained as much information as possible on their present state, and their wishes as to the future; and I hope to draw up a report on the same for the information of H. M. Government; for without doubt, when deciding on the future of this country, some provision should be made for the poor uncivilized beings, to whom by right the soil belongs.

From these Indians I obtained a pair of saddle-bags of which I was in want, and by giving in barter a little ammunition and obacco, I changed a lame horse which I had brought with me or that purpose, for a good strong Indian pony.

Crossing Spetchee or High-woods River on leaving the Indians in the morning, we travelled over undulating prairie all the forenoon, crossing another tributary of this river. During the latter part of the day, we passed through a narrow wooded ravine between rugged hills, covered with burned forest, and camped on a small creek. Here I determined to make a cache. Therefore selecting a good thick spruce tree, we enclosed in a box some ammunition, tobacco, and a few other things, which with half the bag of pemmican still remaining intact, rolled up in a piece of buffalo robe, we suspended from a branch about fifteen feet from the ground.

We were delayed some time next morning by some of the horses having strayed a distance into the woods during the night; however, when found they were quickly unhobbled, saddled, and packed, and we started not very long after our usual hour. The Indian trail led between numerous wooded ridges, but the greater part of the wood was burned. The soil of the valleys was usually a deep dark mould, supporting a luxuriant vegetation of the smaller plants. This is the nature of most of these mountain valleys. Where the strata are upheaved to the surface, the ground is of course rocky; such is, however, not often the case in the valleys, but the lines of strata running along the ridges are distinctly visible even when the grass is growing, owing to the difference of color of the grass on the almost bare rock. The strata run in the direction of the ridges, namely, a little east of south, and usually dip from, but in some few cases towards, the mountains, and at a considerable vertical angle.

In the afternoon we passed close on the left hand a very remarkable feature; it was a mass of rock projecting upwards from the top of a hill, and visible at a considerable distance; from its peculiar form I called it the "Chopping Block." Soon after, we gained the height of land between the waters of the Spetchee and Mocowans, or Belly River, and the wide prairie valley of the latter broke upon our view. We descended a short distance and camped at the first wood and water.

Before gaining Belly River in the morning, the quick and practised eye of the Indian caught sight of a herd of Buffalo in the valley, he therefore went ahead, and by the time we had halted on the river, and I had obtained an observation, he had killed one animal. I remained here until noon, in order to obtain a meridian altitude, and so complete my observation for latitude and longitude, occupying a portion of the time in measuring the heights of the successive river levels with the aneroid barometer.

These "river levels" are a very general feature in this portion of the Western Continent; I have observed them on all parts of

the Saskatchawan above the forks, and its tributaries issuing from the Rocky Mountains, as well as on the Kootanie fork of the Columbia on the west side, and the Flathead River in the mountains, from an altitude of 1000 to upwards of 4200 feet above the sea. They are in some places very marked, and appear as a succession of steps from the bed of the river to the level of the plain above, often in sight for miles, and running horizontally along either side. The tread of the step is of greater or lesser width, the rise nearly always abrupt and well marked. They were very decided in the valley of Bow River at the base of the mountains, where they appeared cut with mathematical accuracy.

The levels measured at Belly River were:—

	Above the sea.
Present bed of the river, - - - - -	4024
1st, river level, - - - - - - -	4085
2nd, " - - - - - - - -	4176
3rd, the level of the valley, - - - -	4226

These river levels are for the most part, on the lower portions of the branches of the Saskatchawan, on a somewhat larger scale in vertical height, than near the sources.

I was now on Belly River at about the same altitude as on Bow River at the site of Bow Fort, namely, 4000 feet above the sea, although eighty-seven miles (geographical) in a direct line S.S.E. from it. From this point the route of the party may be traced on the plan attached to this report. The plan does not include the country to the northward, which has no connection with the passes reported upon. I have, however, the whole country mapped on a smaller scale.

The bed and sides of this river are rocky, the strata of hard gray sandstone, much inclined, and the current obstructed in places by immense granite boulders. We found no difficulty in crossing, the water though running swiftly, being not deeper than three feet, and about twenty-five yards across.

Looking through the gap in the near range through which the river issues, I saw a conspicuously dome-shaped mountain. It afterwards proved to be when seen from the plains, and also from the top of a mountain in the Kootanie pass, the highest and almost only peak rising above the others in this part of the mountains. After the distinguished British naturalist, I named it "Gould's Dome." The gap through which I had seen this mountain was in the eastern or near range, of very regular form, extending with the exception of this gap, for a distance of five and twenty miles without break. The crest of the range was of so regular a form, that no point could be selected as a peak, I therefore gave the whole the name of "Livingston's Range;" it is a very marked feature when seen from the forks of Belly River and the plain outside.

On leaving Belly River we rose considerably, and keeping along under Livingston's Range, the sun had dropped behind this great curtain before we camped. The spot was 540 feet above Belly River which we had left behind to the northward. Looking to the mountains ahead of us, I picked out the most prominent, and took bearings of them before the Indian who was in the rear hunting, came up. There were two near one another bearing thirty miles south, one of which, from the resemblance to a castle on its summit, I named "Castle Mountain;" to the east of these, but at a greater distance a portion of the mountains stretched out to the eastward. From reports which I had previously heard, I took the most easterly one standing by itself to be the "Chief's Mountain," which the Indian on coming up confirmed, and pointed out the place where on the morrow we should turn into the mountains.

This offset range occurs, as I afterwards discovered, just at the 49th parallel or International Boundary line.

The morning of the 20th of August was thick and hazy, with occasional showers of rain, which entirely prevented me from obtaining the good view of the country which I had hoped for, having seen but little in the uncertain light of the previous evening. I therefore travelled on, crossed Crow Nest River, and soon after noon gained the entrance of the Kootanie pass, where another of the branches of Belly River issues from the mountains. Here we struck a narrow but tolerably well beaten track, which the Indian informed us was the Kootanie trail, by which the Indians had crossed the mountains in the past spring. Making a turn therefore to the W.S.W., nearly at right angles to our former course, we followed this track which led up a narrow valley along the left bank of the river and between high wooded hills; the travelling was good, for we were on the even grassy river levels, and we camped at a spot where a small mountain stream entered the river from the north.

We were now fairly in the mountains, and had already overpassed the spot where our Indian guide knew anything of the road but by report; he knew that if all went right we should be some three or four days in crossing, and had been told that there was but one track, and that we were not likely to miss it. It may be asked why was I without a guide? The fact was, that a guide had been allotted to me by Capt. Palliser, but on leaving the camp of the expedition on Bow River, I had started without him on account of the sickness of his wife. He promised to start the following morning and overtake the party, which he failed to do. It will be seen subsequently, however, that I did not suffer by his absence, and I am now glad that he was not of the party, for I have no great faith in the so-called "guides," and think they are seldom worth their pay.

The entrance of this pass is in latitude 49° 34′ N., and longitude 114° 34′ W., being (consequently) forty English miles north of the Boundary line. I have omitted to insert the latitude and longitude of points where I obtained observations, because by referring to the map, the geographical position of any place may be seen.

We started at 5.40 in the morning with the sky overcast, and a drizzling rain, and soon entered thick woods and uneven ground, with a great many fallen trees, which caused the horses to travel slowly. We continued travelling in this way and gradually ascending along the course of a small creek running into Railway River, which we had left where the trail parted from it; this river was so named by me from the striking advantage offered by its "levels" for the entry of a railway into the mountains. Gradually the stream became less and less until after gaining considerable altitude it dwindled into a small quantity of water falling in a cascade. Here we passed Hero's Cliff, an enormous vertical escarpment, facing the east, of hard red sandstone or quartzite, with the strata dipping at least 45° to the west. We now rose rapidly as will be seen by reference to Section No. 1, (the Kootanie Pass); the trees became smaller, and we soon reached the region of rock and alpine plants; here were some large patches of snow and a couple of ponds of clear water; we passed over a quantity of debris of hard grey limestone of which the peaks on our right hand, namely, to the N.W., were composed. As we were now clear of all shelter, we felt the cold damp east wind, which blew a fresh breeze, and drove along scudding clouds which prevented any extensive view. We were now on the watershed of the mountains, the great axis of America; a few steps farther and I gave a loud shout as I caught the first glimpse, in a deep valley as it were at my feet, of a feeder of the Pacific Ocean. It was the Flathead River, a tributary of the Columbia. At the same moment the shots of my men's guns echoing among the rocks announced the passage of the first white man over the Kootanie Pass. I halted for the purpose of reading the barometer, which shewed an altitude of 5960 feet. It was just five hours since leaving our previous night's camp, at an altitude of 4100 feet.

This is no place for a dissertation on the physical geography of North America, but I may simply state, that in that portion of the Rocky Mountains, comprised between the parallels of 45° and 54° north latitude, rise the four great rivers of the continent, namely, the Mackenzie, running north to the Arctic Ocean, the Saskatchawan east to Hudson's Bay, the Columbia west to the Pacific, and the Missouri south to the Gulf of Mexico; thus we may say, that in a certain sense that portion of the mountains is the culminating point of North America, and I

now, on the Kootanie Pass, stood as nearly as possible in the centre of it.

A rapid descent of two hours brought us to the Flathead River, a clear and quick running stream, dividing a beautiful partially wooded valley enclosed by mountains; here we halted soon after mid-day, having passed the great watershed, and descended again 1400 feet without breakfast.

During Sunday I did not move from my pleasant camp, where was wood, good water, and good pasturage, everything to be desired by the traveller. I was engaged in obtaining observations for latitude and longitude, and computing them, writing up my notes, &c.; and I also made a sketch of the mountains over which we had passed the previous day. The men brought in some ducks, grouse and trout, which made an agreeable change in our diet; two or three humming birds were seen about the camp.

The track now led up to the course of Flathead River, through thick forests with occasional openings, crossing several mountain streams, feeders of the river. We halted for breakfast on an open piece of swampy ground. On moving forward again we plunged into thick forests, where the track was greatly obstructed by fallen timber. The Kootanies cut through a good many of the fallen sticks to allow of the passage of their horses, but still the greater number remain as they fall, and cause much twisting, turning, and branching of the track. We ascended gradually, passing a few fine pieces of open meadow, until we arrived near the head waters of the river, when the different streams composing it became mere mountain torrents. Here we commenced a steep ascent, the path ascending in a zig-zag up the hill; the trees, mostly spruce and fir, became smaller until we gained the summit of this knife-like ridge, from which an extensive view of the mountains was obtained. I halted to contemplate the scene, take bearings, and read the barometer, which shewed an altitude of 6100 feet. All appeared, however, utter confusion, such slight differences were there between the different mountains and ridges. One peak alone shewed itself above the general surface. It lay to the northward about thirty miles distant, and I recognized it as "Gould's Dome," which I had previously remarked from the edge of the plains. I estimated it to be not more than 1000 feet above my present position which would give it an altitude of about 7000 feet. The rest of the mountains appeared all about the same level, and but few of greater altitude than the ridge from which I surveyed them; there were visible the main range or watershed, then a number of ridges and mountains densely wooded, and of somewhat less elevation; after which, to the westward, higher mountains, the ranges generally taking a N.N.W. and S.S.E. direction. Such was the

scene to the north of my position, but to the southward the mountains appeared to have no general direction, as many running crosswise as lengthwise. I was now on a height of land between two branches of the Columbia; the rock was the same hard gray sandstone we had observed all along the base of the mountains on the east side, no granite showing itself anywhere.

Heavy dark clouds were gathering rapidly, and the louder and louder rumblings of thunder warned us of an approaching storm. We had descended but a few yards of the great western slope when the tempest broke with all its violence, and we were wet to the skin in a few moments; my own habiliments were far from waterproof, being simply a flannel shirt, a pair of leather trowsers, with a striped cotton shirt over all. The descent was very steep, the horses having in some places difficulty in keeping their legs, although the path was zig-zag; and the continual descending on foot was very trying to the legs. After some distance, however, the descent became less steep, and we continued our course for a couple of hours before coming to any place fit for camping. Although camping in the woods is always to be avoided with horses, we were at length induced to halt from the appearance of some old skelètons of Indian lodges, not knowing how far we might have to travel before coming to any open place; and we camped, for the first time, in a Columbian forest.

The change in the vegetation was first made evident to me on descending the mountain, by the appearance of a beautiful and regularly formed cedar, which for the sake of remembering the tree, I then called the "Columbian Cedar." It flourished at an altitude of about 5000 feet, and I subsequently observed it as low as 3000, but I feel doubtful as to whether it descends to the Tobacco Plains. Besides this I found, to me, a new *Abies* something like the Balsam Fir of the Atlantic slope, but with a rough bark, and growing to a large size; the Spruce and supposed Bank's Pine remained with a few Balsam Poplar and Birch, some of good size; also Maple and Alder as underwood. A new Larch appeared, an elegant tree; and around our camp were the dead stems of many deprived of life, no doubt in years past by fire, rising to an immense height, and tapering upwards perfectly straight, without a limb, to a fine point.

The next day we travelled on through these forests, continually descending, and before noon arrived at Wigwam River, where it passes between two high rocky hills, which, from their imposing appearance from this spot I called the North and South Bluffs. The bed of the river was deeply cut in the valley and exposed grand sand cliffs from two to three hundred feet in height, portions of these cliffs were broken, and pinnacles and blocks of different forms were left, having at a short distance a

most fantastic appearance. The track leaving the river and ascending a steep bank, carried us for five miles over a very rocky piece of country, where the trees were of stunted growth from want of soil, to the junction of Wigwam River with the Kootanie Fork of the Columbia. The former was forty yards wide and two to three feet deep, and the latter sixty yards across with a depth of four to six feet, both running with a swift current, their beds being rocky and stony. The Kootanie Fork could be seen coming down a valley from the N.N.W., from near a well marked mountain about twenty-seven miles distant, which has been called "The Steeples," or Mount Sabine. I believe that not far above the Wigwam tributary another called the Elk River comes in from the north, down a long narrow valley in the mountains. We descended about 300 feet, crossed the small river, and having lost the trail, camped for the night, the Indian's opinion being that we must also cross the main river, which would have occupied more time than the decreasing daylight would allow us. On going lower down the river in search of a better crossing place, I luckily struck on the proper trail leading up the side of the river bank towards the south; so we turned in that night with the satisfaction that we were still to travel in the morning on dry land.

To the west of us, on the other side of the river, was a level, partially wooded country, a portion of the Tobacco Plains, which as will be seen by reference to the plan, is a tract of country of about ten miles in width, stretching from near Mount Sabine on the north, to the southward of the Boundary Line, bounded on the west by low wooded hills, and skirting the feet of Galton's Range on the east. The Kootanie Fork in its southern course, after the entry of Wigwam River, traverses these plains.

Being now at the western extremity of the Kootanie Pass, I will pause to point out the capabilities it affords for a railway across the mountains within the British possessions. I should premise that I have not sufficient evidence to be able to state that the Kootanie Pass is absolutely the most advantageous place for the crossing of a railroad from the Saskatchawan Plains to the Pacific, because the mountains to the north have not yet been sufficiently explored; but I am able to say that it is the most southern line within the British territory, and, as yet, by far the shortest; moreover, I have every reason to believe, that the most suitable portion of the mountains for the passage of a railroad will be found to the south of Bow River.

The Kootanie Pass crosses the Rocky Mountains from the Great Saskatchawan Plains on the east, to the Tobacco Plains on the west, its extremity on the former side being forty, and on the latter, eighteen English miles, to the northward of the International Boundary, the 49th parallel of north latitude. Its

length is 40 geographical, or nearly 47 English miles, extending from longitude 114° 34′ to 115° 24′ W. It leaves the Saskatchawan Plains where they have an altitude of about 4000 feet above the sea, rises 2000 feet to the watershed of the mountains, descends to Flathead River, again to an altitude of 4000, follows up this river to its head waters, then crosses a precipitous ridge, reaching an altitude of 6000 feet; it then descends the great western slope, falling 2000 feet in two miles of horizontal distance, after which, by a nearly uniform grade of 100 feet per geographical mile, it gains the Tobacco Plains at the point where the Wigwam branch enters Kootanie River.

By reference to section No. 1, it will be seen that there are three obstacles to the passage of a railroad; namely, two mountains and one steep slope. As to the mountains, they could, I consider, without difficulty be pierced by tunnels; the great western slope is a more serious obstacle; however, in the following details I hope to show that it also may be overcome.

From the forks of Belly River on the east side, the line would traverse the gradually ascending prairie to the entrance of the pass where Railway River issues from the mountains. This river would be followed up with a grade of 1 in 180, or 34 feet per geographical mile for 7½ miles, the "river levels" affording considerable advantages; leaving this river it would follow the course of my track marked on the map. A cutting of about 3½ miles would lead to a tunnel of nearly five miles in length, which would pierce the Watershed mountain, and come out in the valley of Flathead River, the whole having a grade of 1 in 130, or 47 feet per geographical mile. On emerging into the valley, the line would skirt the base of the mountains to the north of the track, thereby avoiding a steep descent, then following up the river with a grade of 40 feet per geographical mile it would reach the rise of the western ridge, at a height of 5,100 feet above the sea. This would be the culminating point of the line, from which in a distance of ten geographical miles, it has to fall 1,900 feet to the North and South Bluff, and after that, by a slope of 54 feet per geographical mile for five miles to reach the Tobacco Plains, crossing the Kootanie Fork by a bridge. This I propose to accomplish in the following manner. From the culminating point, to pierce the ridge by a tunnel of three geographical miles, and continue the line along the side of the hills to the north of the track, until reaching the North Bluff, the whole with a grade of 190 feet per geographical mile. This portion of the line of ten geographical miles, would have to be worked by a wire rope, and one or more stationary engines. Regarding the remaining five miles to the west of the North and South Bluffs, a careful survey is required to determine whether a grade not too steep for locomotives can be made. My meas-

urements, taken with so uncertain an instrument as an aneroid barometer, must not be depended on to a few feet; they give a fall of 54 feet per geographical mile, or 1 in 112.

As regards the country to the west of Kootanie Fork, I can say nothing, but that no mountains were visible to the distance I could see; neither have I any personal knowledge of the Saskatchawan Plains to the eastward of the forks of Belly River. But it is probable that these great prairies stretch without break from this point to the Red River settlement, and that in the construction of a railroad, little more labor would be required than that of laying down the rails. The following statement of distances to be traversed by a railroad to the Pacific within the British territories may be of interest:—

	Geog. miles.
Lake Superior to Red River settlement, - - -	320
Red River settlement, *viâ* elbow of south branch of Saskatchawan to Rocky Mountains, - -	700
Kootanie Pass, - - - - - - - -	40
West end of Kootanie Pass to mouth of Frazer's River, Gulf of Georgia, - - - -	300
Total, Lake Superior to Pacific, - -	1360

Probable length of railroad, 2300 English miles.

Thus it will be seen that out of the whole distance one-half is over level prairies, and but 40 miles through mountains.

To resume the narrative of my journey: On the morning of the 25th of August, at starting we were obliged to climb the face of a steep hill-side for the purpose of keeping on the left bank of the Kootanie Fork, which here sweeps in close under an outer range of the mountains, having a north and south direction, and which I have called "Galton's Range." We gained a considerable altitude above the river, which ran at our feet, and of whose course I had a view for some distance. The banks were vertical and rocky, and the stream appeared to continue swift. Both horses and men had enough to do in climbing up, and then coming down again from the heights. I was well repaid for my climb by the remainder of the day's travel, which was through magnificent open forests with patches of prairie, sometimes of considerable extent. These forests were the finest it had been my good fortune to see. A splendid species of pine and the larch previously spoken of, with their bright red barks, rose from the ground at ample distances; no brushwood encumbered their feet or offered impediment to the progress of wagons, which might move in every direction.

As we advanced along the prairie the trail forked, and our Indian took the branch which led nearest the river, as from information he had received, he believed it to be that which led to the trading post. Towards evening, according to my reckon-

ing, we crossed the Boundary Line, and camped about two miles within the American territory, and not more than a mile from the river. In a few minutes, a Kootanie Indian came to us on horseback. My Indian guide "James," knowing but a few words of his language, and a little Blackfoot, and he not knowing one word of Cree, we had some difficulty in comprehending that he wished to inform us that there were no people at the trading post, which he described as being quite close. A small present of tobacco and something to eat were thankfully received by him, and he took his leave. Shortly after there came several more from the same camp, having a chief among them. They were mounted on good looking horses, and raced up to our camp as hard as they could gallop, no doubt with the idea of creating an impression. The evening was spent in a talk with them, one of them understanding Blackfoot. It was dark before they took their departure, having promised that they would meet us in the morning at the trading post, to guide us to their camp, where they wished us much to come, saying they had some provisions.

Following the track still S.S.W. the following morning in a thick fog, we came on the river, and within a few hundred yards found three diminutive log houses. Two of them, not over ten feet square, had evidently been used for dwellings, and to enter them it was necessary to crawl through a hole as an apology for a door; the other, somewhat larger, without a chimney, we were informed was the Kootanie chapel which had been erected the previous spring when a priest was there.

The Kootanies afterwards informed me that white people always come in the fall, remaining for the winter trading with them, and returning to Colville, eight or ten days' journey, in the spring. These are the Hudson's Bay Company's people, and this post is the same that figures on maps in large letters as "Fort Kootanie." I remained here till noon, and obtained observations, which placed the post in latitude 48° 55′·5 N., and longitude 115° 31′ W., thus a little over five English miles south of the Boundary.

In the afternoon I rode four miles across prairie in an easterly direction with a chief, the pack animals following, and arrived at the Kootanie Camp, where I was under the necessity of shaking hands with every man, woman and child. The people had a rather dirty and wretched appearance, but their herds of horses, and some few horned cattle, showed that they were not poor.

Having pitched my tent at a short distance from the lodges of the Indians, which were in a pleasant situation near a small stream with some woods along it at the base of Galton's Range, I was soon inundated with presents of berries dried and fresh, dried and pounded meat, and cow's milk. Of course, although no payment was asked, I paid these people for their food in tobacco, ammunition, &c.

Seeing that there was no chance of starving, I determined on remaining here some days for the sake of the horses; the next five days were therefore spent in trading, and exchanging horses, buying provisions, &c., and obtaining by actual observation and Indian report, such knowledge of the country as I was enabled to do.

The weather was fine, and generally calm, but rather warm, the thermometer ranging from 47° to 82° in the shade. I should have said, that in my passage over the mountains, I had experienced no cold nights, the temperature at sunrise being usually about 50°, once only so low as 37°.

I made an excursion to the north of the boundary with my sextant, to obtain as near as possible the precise position of the line; I found no remarkable feature to mark it, but noted the place where it crossed the hills. I also obtained a sketch of the mountains to the northward, Mount Sabine, or as I had myself named it from its peculiar form, "The Steeples," standing out quite distinct from the rest. I may here say, that it was in the neighborhood of this mountain, that Capt. Palliser, following the old Emigrant Pass which he had entered at Bow river, emerged from the mountains after a six or eight days' journey; he then, without however coming to the mouth of the Wigwam branch of the Kootanie river, the true entrance of the pass, recrossed by the Kootanie Pass, which I had previously explored.

I found the Kootanies communicative, and from them gathered the following information:—

That Colville, an American settlement on the Columbia, was about eight or ten days' journey with pack horses, and that they could descend to it by the river in canoes, but there were too many falls and rapids to admit of its being ascended; that the Flathead River, which I followed up in the mountains, runs to the south and joins Clark's Fork of the Columbia, in which is the Flathead Mission, which they described as three days' riding south of this; that there are large lakes to the northwest of the Kootanie Post, from one of which a small river flows and joins the Kootanie Fork, before it falls into Clark's Fork.

They also told me that there was a pass entering the mountains a little to the southward of their camp, and which came out on the east side near the Chief's Mountain; that there were long hills, but not so steep as the Kootanie Pass, and that they used it sometimes when the horses were heavily loaded. This information of another pass in a portion of the mountains that I knew should be explored, caused me at once to decide on recrossing the mountains by this pass, although I knew that it must be wholly or partially on American ground, I therefore prevailed upon a Kootanie to accompany the party across as guide.

There are some considerable tracts of the Tobacco Plains which are prairie; the grass however, does not grow close and thick, but in small bunches with bare ground between, and the pasture is nothing to be compared to that at the base of the mountains on the east side. This is perhaps chiefly owing to the nature of the soil, which in the latter case, is a black mould, while on the Tobacco Plains it is sandy, and in most parts stony; at this season the grass was quite dried up and yellow.

As to the Kootanie Indians, their language at once strikes one as being most guttural and unpronounceable by a European, every word appearing to be brought up with difficulty from their lowest extremities.

They are nearly all baptized Roman Catholics, and are most particular in their attendance at morning and evening prayers, to which they are summoned by a small hand-bell. They always pray before eating. On the Sunday that I spent with them, their service, in which is a good deal of singing, lasted a considerable time; one of their number preached, and seemed to be well attended to.

Their food at this season appears to be almost entirely berries, namely, the "Sasketoom" of the Crees, a delicious fruit, and a small species of cherry; also a sweet root, which they obtain to the southward.

They grow some little wheat, and a few peas; a patch of the former, about forty yards square, which I saw near their camp, although rather small headed, looked well, a proof that this grain thrives in latitude 49° at an altitude of 2500 feet above the sea.

They possess more horses than any Indians I have seen or heard of on the east side, a camp of only six tents, having about 150, old and young. They also, in their treatment, are kind to, and show some knowledge of the animal. They are adepts at throwing the lasso, being brought up from their youth to its use. They possess a certain amount of domestic cattle, six tents having twelve or sixteen head; and I heard of some individuals at a distant camp, who owned as many as twenty or thirty each.

They are perfectly honest, and do not beg, qualities which I have never before met with in any Indians. I extract the following from my journal, written on the spot:—"On taking leave of the Kootanies, with whom I have been camped for nearly a week, it is but justice to say, that they have behaved in a very civil and hospitable manner, and although our clothes and other articles have been lying about in all directions, we have (with the exception of some hide lines, moccasins, and other articles of leather, which the half-starved dogs have eaten) not lost a single article." Whether this honesty is to be attributed to the knowledge of christianity spread among them by the ministers of the

Roman Catholic church, or whether it is innate in them, I can only say that it is a great contrast to the effect produced by the missions in the Indian territory on the east side.

The Tobacco Plains form the country of the Kootanies, but every spring and fall they cross the mountains to the Saskatchawan Plains for the purpose of killing buffalo; they return with supplies of dried meat, &c., with which they trade for blankets, knives, tobacco, &c., with the Hudson's Bay Company's traders at the Kootanie Post. They also sometimes cross during the latter part of winter, when there is sufficient crust on the deep snow of the mountains, on snow shoes, also for the purpose of obtaining provisions, for there is little or no game on the west side.

On the 2d of September, I set out on my return journey across the mountains. The morning was clear and sharp, the thermometer being two degrees below freezing. After I had lost sight of the Kootanie camp, and was riding ahead of my party on a S.S.E. course over undulating prairie, I felt satisfied that I had done all that came under the spirit of my instructions, and was happy to be able to recross the mountains by another unexplored route; my only regret was that this time it was not my fate to see the Pacific.

Leaving the Tobacco Plains at a point where they were pretty thickly wooded we followed a narrow trail, which, turning the south end of Galton's Range, followed up a small creek towards the north end. We crossed a considerable mountain stream coming down a valley from the north, which as it may be of use to the Boundary Commission, I have taken care to mark, and camped at an altitude of 4070 feet. The following day we crossed, soon after starting, some high land, and then descended for the remainder of the day through thick woods till we arrived in the valley of Flathead River. The day after we descended by successive steps to the Flathead River, where it is joined by a creek from the N.W., here I remained till noon for the purpose of fixing the position of this part of the river, which was just 25 miles south of where I had fallen upon it in my progress westward. Several peaks of the mountains showed well from this valley, and I did not lose the opportunity of sketching. A storm coming on drove me to camp earlier than I had intended. We halted on the creek spoken of, and only about half a mile south of the boundary, which according to careful bearings, crosses just over a mountain, which itself has its length nearly in the exact direction of the line. Much rain fell in the afternoon and by the next morning, Sunday, had changed for snow which continued nearly all that day, giving the mountains a good white coat.

On Monday the 6th of September, immediately on starting at 6 A. M. we regained British ground; we travelled up the creek till 10, when we halted for breakfast. It was cold, raw, and clouded. Here we found that the Kootanies, four men and two women, with whom we were travelling, and who had camped here on Saturday, had started this morning for the traverse of the mountains. Suspecting that we had a good days' work before us, I delayed as little as possible at breakfast, and in less than an hour and a half we were again under weigh travelling up the course of the creek, which has some picturesque falls and cascades, caused by the inclined strata of red shale and sandstone. After two or three miles we began a steep ascent, and were soon on ground entirely covered with snow, in which the tracks of the Kootanies who had gone before us were visible. We passed along the edge of a very steep hill, and it was as much as the horses or ourselves could do in some places to keep footing. We now descended, crossed a thickly wooded gully and then commenced the ascent to the water-shed, through thick wood. The snow increased in depth as we ascended, until on arriving at the crest it was two feet on the level, and in places heaped up to double that depth. It was cold work trudging through the snow in thin leather moccasins without socks; and to make matters worse it was blowing and snowing all the time. I however on arriving at the water-shed, with the assistance of the Indian "James," whom I always found most willing, unpacked the horse with the instrument boxes and obtained a reading of the barometer, which gave an altitude of 6030 feet. We ascended *along* the ridge about 100 feet more, and then by a zigzag track commenced a steep descent. It was not however very bad, and we soon arrived at a small mountain torrent flowing eastward, thus regaining the waters of the Atlantic after an absence of sixteen days. The trail continued mostly through woods down the valley due east. The rocks on the tops of the mountains on either side were often of very curious shapes, and the strata in places much contorted; there were also some magnificent cliffs, and the cascades of snow water falling down the narrow gullies, added motion to the grandeur of the scene. The snow gradually decreased as we descended. On arriving at the spot where the valley joined another, I found the Indians camped on a patch of prairie, where I was glad enough to let my horse free, as we had travelled this day from six to six, with a halt of only 1½ hours.

The horses had the first half of the following day to rest, and I took the opportunity of testing my aneroid barometer by the boiling water apparatus, making the ordinary observations, and taking a sketch of a very peculiar peak just above our camp. After two hours travelling on level ground along Red-stone

Creek, we emerged on the Saskatchawan Plains, just six geographical miles north of the 49th parallel, and camped at Waterton Lakes two miles east of the mouth of the pass.

The position of the Waterton Lakes, as will be seen on the plan, is just where the offset range, before spoken of, strikes out to the eastward from the main chain, having the Chief's Mountain at its extremity. The uppermost and largest of these lakes, lies in a gorge in the mountains, and is crossed by the boundary line; the scenery here is grand and picturesque, and I took care to make a sketch from the narrows between the upper or southernmost and second lake.

I was here fortunate enough to discover a stunted species of pine which M. Bourgeau, the botanist of the expedition, had not obtained. I gave him the specimen of this as well as of some ferns and other plants which I had collected.

I was much struck by the comparative greenness of the prairies on this side, after the burned-up appearance of the Tobacco Plains, which we had left but a few days before.

I remained camped at this pleasant spot two whole days for the sake of the horses, and in order to examine more carefully the nature of the country. Game was abundant, including grizzly bears, and we obtained both fresh meat and fish. The trout and pike in the lakes were of large size.

The Chief's Mountain was not visible from the camp, but I obtained a good view of it from a knoll on the prairie about four miles distant, which with my previous bearings enabled me to lay it down, and curious enough, the boundary line passes just over this peculiar shaped mountain, which stands out in the plain like a landmark. I also made a sketch of it.

It will be seen that some of the waters of the Saskatchawan take their rise from the offset range at the boundary line, and from information gained from the Indians, I believe there is a tributary of the South Branch, which rises to the southward of the Chief's Mountain, this may be the Bull-pound River of Arrowsmith; if so, this offset range has nothing to do with dividing the waters of the Missouri and Saskatchawan, and some of the waters of the latter must come from American ground.

We experienced a gale of wind from the southwest, on the night of the 7th, which on the following morning ceased very suddenly, and an opposing wind from the north brought rain and snow, which gave another coating of white to the mountains. This corner of the mountains appeared to be a very windy spot, and when it was not blowing much on the plain, a strong breeze came from the south down the gorge in which is the upper Waterton Lake.

On the 10th of September, I turned my face towards Fort Edmonton, the previously appointed winter quarters of the expedi-

tion, which lay more than three hundred miles to the north, and as will be seen on the plan, passed several creeks, and over a country mostly prairie. I remained at the Forks of Belly River on Sunday the 12th. From this place I visited a camp of forty-five tents of Blackfoot Indians, accompanied by one of my men, and "James," the Cree Indian. I was received with the usual hospitality, and having expressed a desire to change a horse or two, I had no trouble the following morning in exchanging one and buying another for ammunition, tobacco, blankets, old coat, &c. This tribe has the credit of being dangerous, but from what I have seen of them, I consider them far better behaved than their more civilized neighbors, the Crees. I made it a rule never to hide from Indians, and, although I had but a small party, to go to them as soon as I knew of their proximity. I also always told them for what reason the British Government had sent the expedition to the country; and I never failed to receive manifestations of good will, neither was there one attempt made to steal my horses, a practice only too prevalent among the Indians of these plains.

I need not describe my northward journey; suffice it to say that I kept to the east of my former track, along the base of the mountains, except when I turned in for the purpose of raising the cache. I rested at Bow River on Sunday the 19th, travelled over prairie till crossing Red Deer River, the other fork of the south branch of the Saskatchawan, on the 23d; then, passing through a partially wooded country, which I had surveyed in the summer, arrived at Fort Edmonton on the north branch, on the 29th of September.

In this account of the return passage of the Rocky Mountains, by what I have called the Boundary Pass, I have not entered into such details as in the case of the Kootanie Pass, because, as will be seen by the accompanying plan and sections, more than one-half of it lies in American ground; but I have given the same amount of attention to the mapping of it, as I considered a knowledge of that portion of the mountains would be of service to the International Boundary Commissioners at present engaged on the west side. Moreover, I do not consider the Boundary Pass so well suited for the passage of a railroad as the Kootanie Pass.

It will be perhaps noticed that I have said nothing concerning the fitness of the Kootanie Pass for a waggon road. My reason is simply that where a railroad can be constructed, a waggon road can also be made; without considerable expense a road could not be made to pass *over* the two high points, (through which a railroad would tunnel,) in the line of the pack-horse track followed by me; but I have no doubt by taking more circuitous routes, both of these heights might be passed by slopes

adapted for wheel carriages. In other parts the road would follow the line proposed for the railroad.

I have not mentioned the existence of two other passes across this portion of the mountains, called the "Crow-nest" and "Flathead Passes," the former in the British, and the latter in American territory.

The Crow-nest Pass, of which I have marked the general direction on the plan, follows up Crow-nest River, a tributary of Belly River, into the mountains, and gains the west side near "The Steeples." By report of the natives it is a very bad road, and seldom used. I observed the old trail coming in from the plains on the left bank of Crow-nest River.

The Flathead Pass enters the mountains at the 49th parallel of latitude, follows the west shore of Lake Waterton, and gains Flathead River, which it follows to the Flathead Mission on Clark's Fork of the Columbia, about 80 miles S. by E. of the Kootanie trading post. It is used by the Flathead Indians when crossing to the Saskatchawan Plains for the purpose of obtaining buffalo meat.

Fort Carlton, Saskatchawan River, December 15, 1858.

APPENDIX.

[Extract from the address of Sir R. I. Murchison at the anniversary meeting of the Royal Geographical Society, May 23, 1859. p. 103.]

Palliser Expedition.

British North America.—The important results of the exploring expedition under Captain J. Palliser, as communicated by the Colonial Office, and as dwelt upon in awarding the Founder's Gold Medal to that officer, have necessarily given great satisfaction to us, proceeding as they do from men who were especially recommended for this public service to Her Majesty's Government by our Society as well as by the Royal Society.

When Captain Palliser first proposed to make this exploration, one of the main points of interest to geographers was a survey of that part of the Rocky Mountains to the north of the United States boundary which separates the great tracts now named British Columbia from the eastern mass of British North America. Her Majesty's Government deemed it, however, of paramount importance that, in the first instance, the nature of the ground between Lakes Superior and Winnipeg should be accurately surveyed, in order to set at rest all questions of colonization as dependant on the possibility of making practicable routes of communication. For example, whether the Canadas might be brought into profitable communication with the Red River Settlement. The remoter or more western explorations were destined to develop the true nature of the great prairie

region, as watered by the North and South Saskatchawan rivers and their affluents. Collaterally, it was resolved, if possible—and mainly at the instance of this Society—to determine the elevation of the Rocky Mountains in those parallels of latitude, and to point out the passes in them by which communication might be opened out between the vast country occupied by the Hudson Bay Company and the great British seaboard on the Pacific.

In the award of the Patron's Medal to Captain Palliser, allusions have been made to some of the principle results obtained by the researches of the expedition under his orders. But I should not do justice to the leader and his associates, nor to my own feelings, were I not to add a few words of explanation and comment. The first year's labors were necessarily of more importance to the Government than they could be to geographers and naturalists. The great object was to determine the capability of establishing an intercourse between the rocky region of Lakes Superior and Winnipeg on the east and the rich prairie countries on the west; and though astronomical, physical, and magnetical observations of considerable importance were made—these countries being to a great extent known before, and their outlines being monotonous—that portion of the survey created but slight interest among us.

Not so when the Rocky Mountains, to which we had specially directed attention, came to be surveyed.* On proceeding from Fort Carlton, Palliser showed his good sense in approaching these mountains from the rich Buffalo prairies midway between the North and South Saskatchawan. An experienced buffalo-hunter himself, he knew that if his men were not well supplied, by no efforts, however well directed, could they succeed. Accordingly, having established a good base, and having secured abundant provisions at Slauter Creek, he divided his force into three parties. Leading one of these himself across the Kananaski Pass, and returning by the Kootanie Pass in north latitude 49½°, and directing Captain Blakiston to explore the still more southerly or boundary Pass, he sent Dr. Hector to traverse the chain by the Vermilion Pass, and to explore, as a geologist and naturalist, the much loftier mountains into which the chain rises in its trend to the N.N.W. This division of his forces well merited, therefore, the expressions used in the award which has been sanctioned by the Council.

The marked success of the survey accomplished by my young friend Dr. Hector has been peculiarly gratifying to me, inasmuch as I had answered for the capacity he would exhibit in applying his scientific knowledge. Thus, in addition to the determination of latitude, longitude, and the altitude of the mountains and two

* Dr. Hector had, by directions of his chief, made a successful foray in dog-sledges to the eastern edge of the Rocky Mountains during the winter, in which he procured men and horses.

of their passes, Dr. Hector presents us with a sketch of the physical and geological structure of the chain, with its axis of slaty subcrystalline rocks, overlaid by limestones of Devonian and Carboniferous age, and flanked on the eastern face by Carboniferous sandstone, representing, probably, our own coalfields, the whole followed by those Cretaceous and Tertiary deposits which constitute the subsoil of the vast and rich prairies watered by the North and South Saskatchawan and their affluents. His observations on the erratic or drift phenomena are also curious and valuable.

Prevented by his instructions from descending into the valleys of Columbia, and there to ascertain practicable routes to the far west, which he will look out for during the present summer, Dr. Hector, though so severely injured by the kick of a horse as to be incapacitated from moving for some days, contrived so to travel northwards as to round the base of the loftiest mountains of the chain before he returned to his winter-quarters in October, after an absence of eighteen weeks from his chief, but laden with valuable geographical and geological knowledge.

In this survey he had the merit of showing that the Vermilion Pass—which is less than 5000 feet high, and therefore 1000 feet lower than any other known pass of the Rocky Mountains—had another decided advantage over them, inasmuch as its western slope, from the summit level of the horse-path, is so little steep that its explorer has no doubt that even a road for carts may be there established. The descents westward, or into the drainage of the Columbia, in the other passes are exceedingly steep; and according to Captain Blakiston, the Kootanie Pass can only have a railroad made along it by the formation of tunnels of several miles in length, and by encountering the difficulty of the steep western gradient of 194 feet per mile.

Another singular natural feature of comparison is, that whilst the Vermilion Pass is less that 5000 feet above the sea, the adjacent mountains on the north rise to near 16,000 feet, showing the great depth of the gorge. On the other hand, in the range beyond the British boundary, to the south, and where no peak (not even that of Fremont) exceeds 13,000 feet, the passes range from 6000 to 7000 feet high.*

* In anticipation of what may hereafter be published in the 'Journal of the Royal Geographical Society,' the reader is refered to the papers presented to Parliament in April, relative to the "Exploration by Captain Palliser of that portion of British North America which lies between the northern branch of the River Saskatchawan and the frontier of the United States, and between the Red River and Rocky Mountains." These printed documents are accompanied by a map, executed by Arrowsmith, from the surveys of the Palliser expedition, together with despatches of the leader and officers under his command, and tables giving the calculations of latitude and longitude by which the positions of places were fixed. An additional paper and map on the southern part of the Rocky Mountains near the American boundary, as prepared by Captain Blakiston, who had quitted the expedition, has very recently been sent to the Society, with the notice from the Secretary of the

Whether one of the heights called Mounts Brown* and Hooker by Mr. Douglas, in honour of our eminent botanical contemporaries, be still higher than the Mount Murchison of Palliser and Hector, it is certain that the chain diminishes rapidly in its trend from this lofty cluster to the north. We know, indeed, that Mackenzie, the first great explorer of those regions, passed through the range in north latitude 56°, at a comparatively lower level. Again, we further know that in proceeding northwards these mountains dwindle into insignificance before they reach the Arctic Ocean.

It will be recollected that seven years ago Captain M. H. Synge of the Royal Engineers, who had been quartered in the Canadas and had made excursions into the adjacent western territories, being deeply imbued with the importance of the original observations of Mackenzie, and attracted by his glowing description, made a warm appeal in favor of the establishment of a line of communication between the Atlantic and Pacific, by passing from Lake Athabasca and the Peace River, thence traversing the Rocky Mountains on the parallel followed by Mackenzie. But that scheme must now, I apprehend, give way before the

Colonies that it was not to to be looked upon as an official communication until sanctioned by Captain Palliser.† These last-mentioned documents, which seem to me to be also ably prepared, have not yet been laid before the Society. The public will soon possess an excellent map by Arrowsmith, in which all the new discoveries are inserted. This map is entitled 'The Provinces of British Columbia, Vancouver Island, with portions of the United States and Hudson Bay Territories.'

I was recently informed by my friend the Right Hon. Edward Ellice that the geographical position of these passes was laid down many years ago upon a MS. map, at the instance of the Hudson Bay Company, by Mr. David Thompson. I have further learnt from Mr. Arrowsmith, with whom he corresponded, that Mr. Thompson explored the vast regions of the Hudson Bay Company in all directions during twenty-eight years, and projected the construction of a general map of the whole country between Hudson Bay and Lake Suprior on the east, and the Pacific on the west! It appears that the last six years of his labors were spent on the west side of the Rocky Mountains; it being important to note that his MS. maps were all made from actual survey, corrected by numerous astronomical observations. The largest affluent of the Frazer River in British Columbia, "the Thompson," justly bears the name of this great but little-known geographical explorer; and I therefore trust that there is no foundation for a report which has been spread, that it is proposed to substitute some other appellation for the name of this meritorious man. Beginning his astronomical observations in 1792, Mr. David Thompson was in 1817 appointed the Astronomer of the North American Boundary Commission, and was upwards of eighty years of age when he died in Canada. In the words of Mr. Arrowsmith, "he has left no one behind him who is possessed of a tenth part of his acquaintance with the territories of the Hudson Bay Company, whose directors were duly sensible of his great merits." Whatever may be the fate of that remarkable Corporation, we must all admit that it has not only maintained British rights over wide tracts of North America, but has also, in addition to Thompson, produced some of the best geographical explorers of snow-clad Arctic countries, including our medallist Rae; whilst its dealing with the various fur-hunting tribes of Indians have been so equitable as to have maintained the attachment of these poor people, who under such influence have been preserved, instead of falling before the white man as in other parts of America.

* Mount Brown is said to be 16,000 feet high.

† This is the preceding Report.

shorter passages across the mountains in a more southern parallel, and which will, it is hoped, bring a rich prairie country on the east into intercourse with our newly-discovered gold region on the west, as well as with Vancouver Island, the natural resources of which were brought before us by Colonel W. C. Grant. During the animated discussion which took place among us in the year 1851, Mr. Asa Whitney, of the Uuited States, in proposing his gigantic plan of an inter-oceanic railway, candidly told us that the best line of intercourse between the two oceans would be found within the British territories, and the Palliser expedition has already gone far to demonstrate the truth and value of his suggestion.

With a knowledge of the data acquired by the Palliser expedition, men of ardent minds already contemplate the formation of a railroad, or, if not, of a practicable route, which traversing British possessions only, shall connect the Atlantic and Pacific Oceans. But when we reflect that the length of this line is above 2000 English miles, and that the greater part of the route on the east will have to traverse wild and unpeopled regions, we cannot rush to hasty conclusions as to the practicability of such an enterprise. Neither ought we to deride a plan which may be ultimately called for when British Columbia and Vancouver Island shall have risen into that importance which they must attain as British Colonies. For, it is now ascertained, that the tract lying between the North and South Saskatchawan on the east is one of great fertility, where no intense cold prevails, and that, once through the Rocky Mountains, the traveller enters a country of cedars and rich vegetation, in which even wheat may be grown at heights exceeding 2000 feet above the sea. In the mean time we need, at all events, have no hesitation in assuming that the electric telegraph will, ere long, be at work across British North America.

Believing it to be of the deepest geographical importance, that men who have distinguished themselves as Palliser and his associates, should not, through a misplaced economy, be held to their original instructions, and be forced to return homewards by retracing their steps from Fort Edmonton, over the previouly beaten tracts of North America and the United States, I have had great pleasure in supporting the request of the gallant leader of this expedition and of his associate Dr. Hector, that they might be allowed to wend their way home next summer by again traversing the passes in the Rocky Mountains, and thence to explore the great intervening tracts of British Columbia, including the auriferous region of Frazer River. I am happy to say that Sir Edward B. Lytton readily complied with this request, and that the Palliser expedition is thus about to establish fresh claims upon our approbation.

ART. XXXVI.—*On Nitride of Zirconium;* by J. W. MALLET, Prof. Chemistry in the University of Alabama.

(Read before the Amer. Assoc. for the Adv. of Science, August, 1859.)

AMONG the most interesting facts brought to light by the recent researches of Wöhler and Deville upon silicon and the allied elements is that of the strong affinity of these bodies, when free, for nitrogen. Several of the nitrides which result from this affinity have been described—as those of boron, silicon, titanium, and tantalum. I have now to add to the list *nitride of zirconium.*

This substance was obtained under the following circumstances. The ease with which silicon and boron may be crystallized by exposing the elements in the amorphous state to a very high temperature, in contact with aluminum, which when fused seems to act the part of a solvent, led very obviously to the expectation that other related elements might also be obtained in crystals by this process. Titanium and zirconium suggested themselves as specially worthy of experiment in this direction. With the exception of the bare notice* that Deville, by heating aluminum in a porcelain tube traversed by a mixed current of hydrogen and a vaporized chlorid, had obtained crystalline silicon, boron, carbon, *zirconium*, and *titanium*, I have seen no account of the preparation or properties of the last two. Deville and Wöhler have indeed stated at a beginning of a paper† on nitride of titanium that this substance was first noticed by them in the attempt to procure titanium itself in a compact state—but the means proposed for the attainment of the latter object are not mentioned.

A quantity of amorphous zirconium and titanium was prepared by heating the potassio-fluorids with sodium in an atmosphere of hydrogen, and it then remained to be seen whether the metals could be brought into the crystalline state by exposure to intense heat in contact with aluminum. A small piece of aluminum was placed in the cavity of a lime crucible (of the kinds proposed by Deville), and was then surrounded with black pulverulent zirconium, which latter was pressed down as closely as possible, and covered by a layer of quick-lime in powder, also strongly pressed. A stopper of solid lime was fitted to the opening, and the whole was exposed for about an hour to the heat of a small blast furnace capable of melting platinum.

After cooling, the crucible was removed from the furnace, and was found to be *slightly cracked.* This no doubt occurred at the beginning of the experiment, and was caused by the too

* Paris correspondence in Amer. Jour. Sci., May, 1856, p. 404.
† Ann. d. Chem. u. Pharm., August, 1857, S. 230.

rapid application of the blast. On breaking the crucible across, the interior presented the appearance of a porous mass of dark gray color, through which globules of aluminum were scattered. This mass was placed in dilute muriatic acid, and began in part to dissolve with effervescence.

A few iron-black shining scales, like those of graphitic silicon, separated out, and these perhaps constituted the original object of the experiment—that is, were zirconium in the form corresponding to graphite. The color and lustre were very like those of silicon in this form; the scales appeared however to be thin and flat rather than needle-like; no definite angles or planes could be seen under a high microscopic power. In another experiment these scales were obtained in larger proportion, excluding, I think, the likelihood of their being silicon itself, derived either from the aluminum or the lime; the absolute amount, however, was very small, and no chemical examination of these scales could be made.

As the acid continued to act upon the mass taken from the crucible, bright surfaces and little veins of golden color and lustre made their appearance, and here crystalline structure became apparent under a common pocket-lens. It was necessary, however, to use a pretty high microscopic power in order to bring out the form of the very minute specks which formed these gold-like crusts; with a magnifying power of 400–600 they were seen to consist of distinct cubes, the largest of which were not more than the one-hundredth of a millimetre on the side. The color and lustre were those of gold, and the appearance of some of the microscopic specimens was very beautiful, the little cubes being imbedded in a colorless glassy matrix, probably a compound of zirconia and lime. One was reminded by them of the titanium cubes of the iron smelting furnaces.

This gold-colored substance was but very slightly acted on by the common acids, even the nitro-muriatic, or by the alkalies in solution; fused with caustic potash it gave off ammonia in abundance, thus proving the presence of nitrogen. Its composition was not determined quantitatively, owing to want of sufficient material, for much of the zirconium had combined with the oxygen of the air, but a part uniting to the nitrogen. The nitride in contact with water at common temperatures, appeared to undergo in some slight degree the same decomposition that Deville and Wöhler* have remarked in the case of nitride of silicon, ammonia being formed.

It having been shown that zirconium is capable of uniting directly with the free nitrogen of the air, one or two experiments were made with gaseous compounds of nitrogen.

* Ann. d. Chem. u. Pharm., Mai, 1859, S. 249.

Amorphous zirconium was heated in a Bohemian glass tube up to the temperature at which the latter softened, a stream of ammoniacal gas being passed through it. At a low red heat there suddenly appeared a bright glow, spreading rapidly over the metallic powder, and then disappearing; this was probably owing to the presence of a little hydrate of zirconia, the water of which, as Berzelius has shown, yields oxygen to the metal when heated. After cooling, the tube was found to contain a dark gray, perfectly amorphous powder. Under the microscope it could be seen that the gray color was due to a mixture of white and black particles; the white being no doubt zirconia, produced partly by the presence of hydrate as just noticed, and partly by the fact that the ammonia had not been perfectly dried. The gray powder was gently heated in the air to drive off any free ammonia, and then fused with caustic potash; it gave off ammonia in abundance. Heated to low redness in the air, it took fire, glowed brightly, and even continued to burn when removed from the lamp-flame. It burned almost white, and when afterwards fused with caustic potash, gave only traces of ammonia.

A similar amorphous gray powder was obtained by heating the anhydrous chlorid of zirconium in gaseous ammonia, chlorid of ammonium and hydrochloric acid volatilizing. Unfortunately the ammonia was not quite dry, and in consequence the color of the powder was light, showing the presence of but little nitride; on fusion with caustic potash but little ammonia was given off.

Lastly, pulverulent zirconium was heated to a bright redness in a tube of Bohemian glass, through which passed a stream of dry cyanogen. The glow alluded to above appeared and spread over the mass. On cooling, an amorphous powder was obtained, of black color with a shade of chocolate-brown; this, after gentle heating in the air, was fused with caustic potash and gave off ammonia in large quantity. Strongly heated in the air, the powder took fire, and burned nearly white; after burning, it gave with caustic potash slight but distinct traces of ammonia. The black powder was not dissolved by muriatic acid, and appeared to be scarcely affected by the nitro-muriatic acid. Hot oil of vitriol seemed to act on it but slightly and very slowly; the acid became brown, and a little gas, apparently sulphurous acid, was given off; hence it is probable that this powder contained carbon—was perhaps a nitro-cyanid.

These experiments would seem to show that—

(1.) Zirconium, like titanium, silicon, and boron, has a strong affinity for nitrogen, is capable of removing it from some of its compounds, and will even unite directly with it when free and inert, as in atmospheric air.

(2.) The relation, thus indicated, of zirconium to titanium and silicon, supports the evidence afforded by the late experiments

of Deville and Troost on the vapor-density of chlorid of zirconium, which appears to have the formula $ZrCl_2$, analogous to $TiCl_2$ and $SiCl_2$.

(3.) Zirconium has probably not quite as strong an affinity for nitrogen as some of the other elements named above. As prepared from ammonia or cyanogen at least, its nitride burns when strongly heated in the air, like the nitride of niobium of H. Rose,* and perhaps the nitrides of tungsten and molybdenum;† in contact with water nitride of zirconium is probably subject to slow decomposition, like nitride of silicon.‡

(4.) It would be desirable to examine the action of chlorine upon this nitride of zirconium at a high temperature, so as to ascertain whether cyanogen may exist in any of the specimens prepared by different methods; also to endeavor to obtain the compound in crystals of larger size, and to get a qualitative analysis of it in a state of purity.

ART. XXXVII.—*On the Atomic Weight of Lithium;* by J. W. MALLET, Prof. Chemistry in the University of Alabama.

(Read before the Amer. Assoc. for the Advan. of Science, Aug. 1859.)

IN a paper read before the American Association for the Advancement of Science in August, 1856, I endeavored to show that the equivalent of lithium, which has been usually taken, on the authority of Berzelius, as 6·5 (=81·25 on the oxygen scale), or 6·6 (=82·50), is in fact considerably higher, and may be assumed =7· (or 87·50).

The error involved in the older determinations was noticed as due to the fact, observed by Marignac and others, that when a sulphate (the salt analyzed) is precipitated by an excess of chlorid of barium, traces of the latter are thrown down with the precipitate and cannot be removed by washing, thus bringing out the quantity of sulphuric acid greater, and the atomic weight of the base less than the truth.

My own results were obtained by the method used by Pelouze in determining the equivalents of sodium and barium, namely, the precipitation of chlorid of lithium by a solution of silver of known strength. In this way the equivalent of lithium was found by three experiments =86·93, 86·96, 86·45, or in the mean 86·78 (or 6·95 as referred to the hydrogen unit).

Since the publication of the above result, it has been confirmed by Dumas, who, in one of his recent papers on the equivalents of the elements, states that he has found that of lithium

* Ann. d. Chem. u. Pharm., Mai, 1856, S. 140. † Ibid., Feb. 1858, S. 259.
‡ Ibid., Mai, 1859, S. 249

=7·, without however giving the details of the experiments on which this number is based.

On the other hand, Troost, in a paper upon the general history of lithia and its salts,* has objected to the method by which my determination of the equivalent was made, and has returned to a number near that originally given by Berzelius. Troost states that chlorid of lithium on being heated in the air loses chlorine and takes up oxygen, so that it must give by the method of Pelouze an atomic weight for the metal higher than the truth. This fact was distinctly noticed in my former paper, and it was stated that the decomposition might be prevented by addition of a little pure sal-ammoniac to the chlorid of lithium before heating. Troost objects to this, not that he has proved the method of correction defective, but that we cannot in the end tell whether the salt contains its full proportion of chlorine or not, unless the true equivalent of lithium—the constant we are in search of—be known. But it is to be remarked that the product of the exchange of chlorine for oxygen is caustic lithia, exhibiting a strong alkaline reaction. I have twice or thrice prepared chlorid of lithium, adding sal-ammoniac, and igniting in a well closed platinum crucible, and have always found that several grams dissolved in a very small quantity of water (the salt is extremely soluble) gave not the slightest alkaline or acid reaction with the most delicate vegetable colors.

Troost himself adopts crystallized carbonate of lithia as the salt to be analyzed in order to determine the equivalent. He precipitates the carbonate, washes it thoroughly, diffuses it in water through which carbonic acid gas is passed until the salt dissolves, evaporates the solution until the carbonate is deposited as a crystalline powder, and dries this powder at 200°. He determines the lithia in one portion of the salt by evaporation with pure sulphuric acid, and the carbonic acid in another portion by noting the loss of weight on fusion with silicic acid. In this way he arrives at the number 6·6 (=82·5). No proof is offered that exposure to a temperature of 200° is capable of removing every trace of water and all carbonic acid over a single equivalent; yet, unless this be effected, the atomic weight of lithium will be brought out less than the truth. The same result will follow from the mechanical loss of the least drop of fluid during the effervescence of the carbonate with sulphuric acid or the subsequent evaporation of the sulphate of lithia; and, without feeling the slightest doubt of the manipulative skill of the French chemist, we must admit that, in so delicate a process as the determination of an atomic weight, the solution of a carbonate and evaporation of the solution—steps which are generally

*Ann. de Chim. et de Phys., [3], t. LI, p. 108.

looked upon as undesirable in the common course of analysis—should, if possible, be avoided.

I have recently made a new determination of the equivalent, deriving it now, from experiments upon the sulphate of lithia; applying, however, a method avoiding as I hope the source of error to which Marignac has drawn attention; an error which threw much difficulty in the way of his successful estimation of the atomic weights of cerium, lanthanum, and didymium. If we add a salt of baryta in excess to a solution of any sulphate, the precipitate usually contains a small amount of the soluble barytic salt, which cannot be washed out, and which therefore increases the apparent amount of sulphuric acid present, if the latter be calculated from the weight of the sulphate of baryta, supposed pure. On the other hand, if the soluble sulphate be in excess, it will mix with the precipitate to some extent, and thus the proportion of sulphuric acid may be brought out higher or lower than the truth, as the equivalent of the base under examination is lower or higher than that of baryta. So that, if we wish to determine the atomic weight of lithium, as Berzelius did, by mixing the solution of a known amount of sulphate of lithia with chlorid of barium and weighing the sulphate of baryta precipitated, we are not certain that the weight of the latter really corresponds to the quantity of sulphuric acid in the salt analyzed. The same objection applies to Marignac's analysis of the sulphates of cerium and the allied metals. He there noted the volume of a solution of chlorid of barium of known strength required to precipitate a weighed portion of the sulphate; when a precipitate ceases to form, more or less chlorid of barium may have been used than is really equivalent to the sulphuric acid present.

The amount of the above error, must however be constant if the sulphate precipitated, the salt of baryta used, and the circumstances of precipitation be all the same. If the same salt of baryta be used to precipitate *different* sulphates, it is probable that the amount of error will be different for each. But, if we take the sulphates of two very similar and closely related bases, it is probable that *the difference* in the amount of error will be very small. These considerations have led to the following method for determining the equivalent of lithium.

Sulphate of lithia was prepared, with all possible care, from the carbonate, and tested rigidly as to its purity. Two separate portions (A, 1, and 2,) of this salt were rendered anhydrous by cautious application of a heat below redness, and accurately weighed. Two similar portions of perfectly pure sulphate of *soda* (B, 1, and 2,) were dried and weighed with equal care. And, lastly, two portions of pure sulphate of *magnesia* (C, 1, and 2,) were in like manner dried and weighed. Soda and magnesia

were chosen for comparison with lithia because the last-named base seems in most of its relations to hold an intermediate place between the former two, with which it is closely allied. Chlorid of barium was also prepared with all the precautions needed to ensure its purity, precipitated twice from its aqueous solution by alcohol, and recrystallized three or four times. It was at last obtained as a fine crystalline powder by stirring the hot saturated solution as it cooled, and this powder was allowed to dry spontaneously in the air at a temperature of about 80° F. Thus prepared, the salt—as Marignac has shown—is not altered in weight by further exposure to air, its theoretical composition is $BaCl+2HO$, the precise amount of water actually present was probably a little greater, owing to the mode of drying, but was unimportant under the conditions of experiment adopted.

For each of the six weighed portions of sulphates mentioned above, the quantity of chlorid of barium needed for exact precipitation was calculated, assuming the equivalent of sodium =23, that of magnesium =12, that of lithium =7, and that of barium =68·6, and considering the chlorid of barium as containing strictly two atoms of water. Six portions of the last-named salt were weighed out (at the same time), each less than the amount calculated by one or two centigrams. Each was dissolved in 200 cubic centimetres of hot water, and added to its corresponding portion of sulphate, likewise dissolved in 200 cub. centim. of hot water. The fluid and precipitate in the six beakers were well stirred, and left to settle.

A solution was now prepared of 1 gram of the crystallized chlorid of barium (weighed out at the same time with the larger portions) in 1 litre of water, each cubic centimeter corresponding therefore to 1 miligram of $BaCl+2HO$. With this standard solution, dropped from a pipette whose degrees $=\frac{1}{5}$th of a cubic centim., the precipitation of the fluid in each of the six beakers was completed—the amount of chlorid of barium thus employed was noted, and added to the weight of the main portion originally taken. At first it was easy to observe the formation of a precipitate on each successive addition of the chlorid of barium solution, and subsidence took place quickly; but, as the point of exact neutralization was more and more nearly approached, each observation became more difficult, and hours and even days were required in order to observe the production of a cloud by each drop added, or to get the fluid clear again for another trial. When the last addition of chlorid of barium altogether failed to produce a precipitate, a single drop of a solution of sulphate of soda was added, and the formation of a cloud noticed.

In this way the following results were obtained:—

A, 1.—3·8924 grm. of LiO, SO_3 required for complete precipitation 8·6323 grm. of $BaCl+2HO$ as used.

A, 2.—4·6440 grm. of LiO, SO_3 required 10·2940 grm. of BaCl+2HO.

B, 1.—5·0675 grm. of NaO, SO_3 required 8·6920 grm. of BaCl+2HO.

B, 2.—5·1107 grm. of NaO, SO_3 required 8·7688 grm. of BaCl+2HO.

C, 1.—4·3380 grm. of MgO, SO_3 required 8·8318 grm. of BaCl+2HO.

C, 2.—4·6625 grm. of MgO, SO_3 required 9·4872 grm. of BaCl+2HO.

Calculating now from B, and C, the amount of crystalline chlorid of barium necessary to precipitate *an equivalent* of NaO, SO_3 or MgO, SO_3, we get the following numbers, which represent what may be called *the practical equivalent* of the chlorid of barium as actually used.

		Means.	
From B, 1.	121·78	121·80	121·96
" " 2.	121·82		
" C, 1.	122·15	122·12	
" " 2.	122·09		

the theoretical equivalent of BaCl+2HO being 122·1—the presence of any water over the normal two atoms tends to raise the practical equivalent—the presence of any BaCl in the precipitated BaO, SO_3 has the same effect,—the presence of either of the soluble sulphates in the same precipitate leads to an opposite result. From this practical equivalent of chlorid of barium and the results given above under A, 1, and A, 2, we may calculate the equivalent of lithium. If we adopt for chlorid of barium the number 121·80—that obtained by the precipitation of NaO, SO_3—we have for A, 1,

$$\frac{3{\cdot}8924+121{\cdot}80}{8{\cdot}6323}=54{\cdot}92=\text{LiO, SO}^3$$

$$54{\cdot}92-48(\text{SO}_3+\text{O})=6{\cdot}92=\text{Li}$$

and for A, 2,

$$\frac{4{\cdot}6440+121{\cdot}80}{10{\cdot}2940}=54{\cdot}95=\text{LiO, SO}_3$$

$$54{\cdot}95-48=6{\cdot}95=\text{Li}.$$

The mean of the two results is 6·935.

If we take for chlorid of barium the number 122·12—derived from the experiments with MgO, SO_3—we get by a similar calculation,

From A, 1, - - - - - -	Li=7·07.
" " 2, - - - - - -	Li=7·09.

or, in the mean, 7·08.

Lastly, if we take the mean of the two numbers for chlorid of barium, namely, 121·96, we get for

A, 1,	- - - - - - -	Li=6·99
" 2,	- - - - - - -	Li=7·02

or, in the mean, 7·005.

Hence, we find, that the equivalent of lithium, as deduced from the mean results of the above experiments, comes out

6·935 (=86·69 on the oxygen scale)
7·080 (=88·49 " " " "
7·005 (=87·56 " " " "

or as we take the *practical equivalent*, or actual precipitating power, of chlorid of barium from the experiments with NaO, SO_3, those with MgO, SO_3, or the mean of the two, these numbers exhibiting close agreement, and obviously indicate 7· as the true equivalent of the metal. It will be observed that the above method is independent of a knowledge of the exact equivalent of barium, and uses chlorid of barium merely as a means of bringing sulphate of lithia into comparison with the sulphates of soda and magnesia—the equivalents of the two last named bases may be considered as ranking among those best established—and the small difference between *the practical equivalents* for chlorid of barium deduced from these two shows the probable extent of error involved in the assumption of the same constant in the precipitate of the sulphate of lithia.

While these results confirm those formerly obtained by the analysis of chlorid of lithium, I do not consider them of superior or perhaps even of equal value. The estimation of chlorine by the method of Pelouze is apparently one of the most simple and exact processes for the determination of an atomic weight which have ever been proposed, and it is, as I believe, fully applicable to the case of chlorid of lithium.

As the result of both sets of experiments we may fairly take the number 7· (=87·50) as representing the true equivalent of the metal.

ART. XXXVIII.—*Notes on certain Ancient and Present Changes along the Coast of South Carolina*; by OSCAR M. LIEBER, State Geologist, S. C.

IT is very evident that remarkable changes have taken place on the coast of South Carolina during the present geological epoch; changes, which have effected or are yet, effecting very conspicuous alterations in the contour of the coast as well as in the hydrography of the immediate interior, and the elevation

and character of the land. Five or six prominent effects of change I think may thus be distinguished:

I. An ancient depression along our coast.

II. A total change in the course of the portions of the rivers near the coast.

III. A more recent superficial elevation of the coast and—

IV. Consequent gradual seaward extension of the coast.

V. A present depression of the coast and

VI. A southward translocation of our littoral islands.

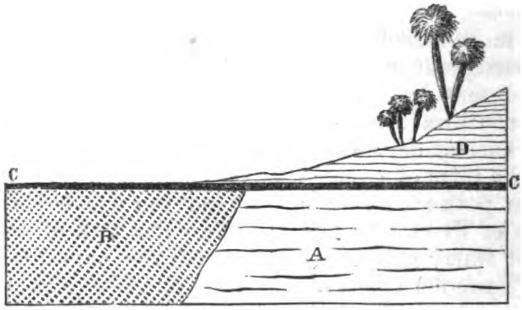
Of the ancient depression of the coast we find an indubitable proof in the piles of oyster shells accompanied by charred wood and Indian pottery, found in ditching the rice fields sometimes at a depth of five or six feet, and near the level of low tide at a distance of thirty miles frequently from the mouth of the river, (as at Mr. Langdon Cheves' plantation opposite Savannah). This fact also seems to indicate that the coast must, at the time that these oyster piles were formed, have been far nearer, for the distance from the sea would be too great to render transportation likely. It also shows the gradual rise of the land by surface accumulation, of which, of course, there are many other indications in the fertile alluvium of the rice-lands.

The formation of some of these rice-lands is itself connected with a remarkable change in the general character of the seaboard. Let us take Cooper river for instance, as that affords one of the most remarkable cases in the State. Any map of moderate accuracy will show that the length of this river bears no proportion to its width. At the same time it is accompanied on either side by wide bodies of alluvial accumulations, which could not possibly have had their origin in material derived from the adjacent country, which, with the solitary exception of an occasional bluff of eocene marl, (as at Mepkin), is a region of pure and coarse sand, whose effects, wherever it is washed into the rice-lands, is materially injurious.

The rice-lands themselves are composed of a rich tough loamy soil having at times a thickness of sixty feet (*d* in Fig. 2, B in fig. 1), containing no visible organic remains—not even infusoriæ, as Dr. E. Ravenel informs me—but perfectly homogeneous in its composition. Upon this substance rests a stratum composed either of the remains of marsh grass or of drift-wood and bay-roots, &c., according as the surface is more or less exposed to the tidal inundations of salt water. This stratum is observed at C C in fig. 1. In those places where it is regularly covered by salt water, the accumulations of the whitened shells of dead mollusca are often visible even at a distance. C C is evidently a far newer formation than B and altogether distinct in its origin. There are cases, for instance close to Dr. E. Rav-

enel's residence, where the stratum, C C, may be observed to extend into the adjacent sand bank, while at another point on

1.



the same plantation the drift wood contained in this bed, was struck at a considerable distance from the edge of the bank. D, therefore, assumes the appearance of a drift-sand. A, may either represent earlier sand strata (probably post-pliocene, but containing no fossils), clearly marked, highly fossiliferous post-pliocene clays and marls, or the more durable eocene marl beds.

In some places the bed, C C, presents an extremely light, semi-peaty mass of greatly increased thickness (as on Savannah river: Mr. Cheve's plantation, &c.), when dry it ignites with the greatest ease, leaving scarcely any ash. Of this feature advantage has been taken to reduce it to the level of the rice-fields now in cultivation, where its natural elevation and more inland position raises it above the tidal irrigation, it is then annually burnt off. For one year it will then yield a good corn crop, by repeating the operation its level is gradually reduced, and the land which it covers rendered available to rice-culture. (L. C's plantation.)

We have seen that the stratum, C C, often underlays the adjoining sand hills, while the far more massive bed, B, terminates abruptly on striking either the marl-bluffs or the solid sand-banks. C C, is therefore not the more recently accumulated part of B; but entirely independent.

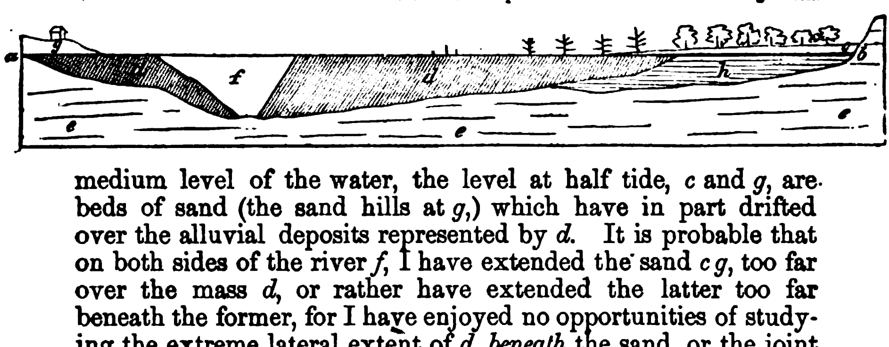
With rivers like the Savannah, the Santee and the Pedee we find the source of the mass B at once explained by the presence of those water-courses. But with rivers like the Combahce, Ashepoo, and especially the Ashley, Cooper and Wandoh, no such existing source is visible. The present streams do not extend sufficiently far into the interior, nor do they drain sufficiently fertile regions to have been able to accumulate so very rich a deposit; yet they are the very ones, where this stratum is observable in its greatest development. If we notice the great ramifications of the swamps of this region, the solution, how-

ever, becomes apparent, and we are then taught that these rivers did at one time drain large portions of the back country, the Santee having probably at one time debouched into the Atlantic near Charleston. Subsequent driftings of the sands of the region have in part obliterated the boundaries of the connecting swamps, but over the greater distance we may yet trace them with considerable facility. The homogeneous unstratified character of the deposit, B, and the marked absence of drift-wood, appears to me to render it likely that it was the result of a gradual but constant sub-aqueous deposition of sand, and that such freshets did not occur in those days, which now transport trees and logs from the interior. We have ample and historical proof indeed that these fluvial inundations have greatly increased since the clearing and cultivation of the "Up-Country."

Where the bodies of land, to which we have just devoted our attention, are situated near the sea-coast, the horizontality of their surface affords us an exceedingly reliable guage, by which to determine the changes in elevation which take place on our sea-board.

In fig. 2 I have given an ideal section, which might represent a section across Cooper river. In this figure, *a b*, represents the

2.



medium level of the water, the level at half tide, *c* and *g*, are beds of sand (the sand hills at *g*,) which have in part drifted over the alluvial deposits represented by *d*. It is probable that on both sides of the river *f*, I have extended the sand *c g*, too far over the mass *d*, or rather have extended the latter too far beneath the former, for I have enjoyed no opportunities of studying the extreme lateral extent of *d*, *beneath* the sand, or the joint boundary of the older sand bed *h*, and of the marl beds *e*, beneath *d*. Undoubtedly the case presented in fig. 1 is the most common, and the eocene beds which appear in high bluffs on the east and show themselves in the bed of Cooper River, may therefore lie much nearer the surface on the west side, than I have here represented. This has however little to do with the question which we now approach.

It has been said that a gradual depression and submersion is manifest on our coast. This I have endeavored to exhibit in

fig. 2. Passing along from the river, we first observe a strip of marsh, containing no remains of a forest growth, next we come to a portion already entirely covered by the high tide, where the stumps of the most enduring trees—the live oak—may yet be seen. After this we enter another portion where the marsh growth is not universal, and in which pine and other trees, dead in part, though still standing, may be found. The soil is sandy. Leaving this we pass through a strip of dying forest into that which is still living, but upon which the salt water is gradually but surely encroaching. In all its varied stages we thus perceive the effects of this depression. The salt water gradually moistening the soil around the roots of the trees, they speedily sicken and die, and before the depression has sufficiently advanced to allow the tides to cover the surface and develop a complete saline vegetation, most of the trees have fallen and decayed, a few isolated stumps of live oaks alone remaining to mark the presence of the ancient forest. Dr. Ravenel had the kindness to show me some points on his plantation where this fact is exhibited in the highest degree of perfection.

To what then can this submersion be due? Mr. Tuomey in his "Geological Report on South Carolina" explains it as resulting from land-slides. He regarded it as produced by the washing away of underlying quick-sands, numerous local instances of which are indeed presented. Thus at Cainhoy, the famous post-pliocene locality on Wandoh river, we observe such slides, where the water has gradually undermined the sand banks. The trees in consequence, assume vertical or slanting positions, in accordance with the circumstance of the action of the water and the extent to which their roots afford them support. But I am induced to believe that such action must be purely local. The far more conspicuous phenomenon to which I refer, can scarcely be satisfactorily explained in a like manner. The single slides rarely extend inland beyond twenty-five feet, while the submersion referred to, is often clearly observable for a distance of at least a mile. Moreover the slides or land-slips are sudden and accompanied by true faults, which are in no instance observable in the other case, nor could the washing away take place except with abrupt banks.

A better explanation, it seems to me, might be sought in a gradual compression (a *settling*) of the deposit *d*, though even that, appears to me too local, apart from the fact, that such settling is not likely to exist with a bed, which is constantly exposed to the same, or even to an increased quantity of moisture, and which has already for such an unknown time enjoyed all the facilities for compression, without any present increase of weight above it, from which we might deduce an accelerated action of the kind. To me a positive submersion of the coast,

dependent upon far more vital changes of the crust of our globe, —such as have already been observed in other regions of the world—appears to offer a much more satisfactory explanation. No other suggestion it seems to me can explain the growing inroads of salt water; where neither steep bluff-banks, underlying sand beds or alluvial deposits exist. In addition to this we have already in an earlier part of this communication believed ourselves enabled to detect ancient effects of a similar kind and in so far, at all events, we are supported by analogy when we assert, that a sure and positive though very gradual submersion of our coast is now in progress, at a future day perhaps to be replaced by a gradual elevation.

Another change in the contour of our coast is observable, though confined in its effects. I allude to the gradual southward translocation of our sea-board islands. The northern extremities are constantly washing away and the southern beach extending with equal regularity. This is very beautifully marked with some of the Hunting Islands near Beaufort. Thus Col. B. J. Johnson pointed out to me the spot where he had shot his first buck, which is now a hundred yards or more out in the Atlantic. This change is no doubt due to littoral counter-currents in the Gulf Stream.

Camp Geol. Survey, S. C., August 7, 1859.

Art. XXXIX.—*On the Sudden Disappearance of the Ice of our Northern Lakes in the Spring;* by Gen. J. G. Totten, Chief Engineer, U. S.

(Read before the American Association for the Advancement of Science, held at Springfield, August, 1859.)

Some forty years ago, being at Plattsburgh, N. Y., on the margin of Lake Champlain, and not far from the widest part of the lake, I had a favorable opportunity for studying the phenomenon of the sudden disappearance of the great body of the ice covering that lake, a body of very many square miles in extent, and not less than one foot in thickness.

This striking phenomenon has often given rise to wild speculation and conjecture in the unscientific world. It was the subject of discussion some years ago in this Association, and it is under the impression, perhaps erroneous, that full information was not then and has not been since presented, that I now venture to produce the following substance of my observations, though made chiefly at that distant day.

At the close of a day in April, I think, the whole surface of Lake Champlain, with the exception of a very few "air holes"

or unfrozen portions of at most a few acres each, and a strip of water next the shores, was one great expanse of ice, of a thickness not less than twelve inches, and apparently, looking merely at the surface, as solid as ever.

During the following night there arose a strong wind from the southward, blowing, therefore, nearly lengthwise of the lake; and when I looked out the following morning not a particle of ice was to be seen, but instead thereof, a lively play of water sparkling with "white caps." There was, as determined by immediate and close examination, absolutely no ice upon the water nor in the water; not a fragment, large or small. Upon the lee shore of a bay close at hand, there was however, a fringe of broken ice that had been washed up by the waves; and in the condition of these few remains of the night's work was to be found, it seemed to me, a satisfactory explanation of a change certainly very surprising from its suddenness and completeness, and deemed indeed, even by high authority in philosophy, so much to partake of the marvellous as to require a higher solution than philosophy was able, consistently to supply.

I venture, in offering this mite to the collections of the Association, to give the explanation then suggested by my examinations; because, as intimated before, I am not aware that such particulars as I have to describe, have been connectedly given, although they must have been often exhibited to individual observation, and as often, one would think, have led to a explanation simple, satisfactory and clear within the domain of the consistent philosophy that nature loves.

The fringe of broken ice was found to consist wholly of prismatic fragments, all of which, excepting a few broken transversely, were of uniform length, namely a length exactly equal to the thickness of the mass of ice of which they had been portions.*

The sides of these fragments were irregular as to number and form; the breadth or thickness varying sometimes in the same prism from three-quarters of an inch to an inch and a half—perhaps a little more or less; but notwithstanding such variations, there was a general agreement as to shape and size, and the general result in all was a decidedly prismatic form. There were,

* The following description and remarks, as far as relates to details, belongs to the particular case then—so much to my astonishment and surprise, presented to notice. I have observed since, that the circumstances under which bodies of fresh-water ice are formed, are not always favorable to so clear an exhibition of the law of structure. The vertical arrangement of elongated solid pieces, although sometimes quite irregular as to shape and dimensions, and interrupted, lapping in their length, is however, I believe, always to be seen in blocks of ice in which solution is somewhat advanced, and to be detected by cleavage, unless indeed, the process of congealation has been disturbed by forces too great for an observance of the law of crystallization. Such deviations do not however, it is thought, touch the general conclusions to which our case seems to lead us.

moreover, sometimes to be seen upon their irregular sides, portions of some length that were probably true crystalline faces. Excepting a small portion at one end of each that was evidently made up of half-melted and refrozen snow, they were very transparent, with few air bubbles, and as sonorous, nearly, as similar prisms of glass.

Examinations then and afterwards of floating fresh-water ice, (which alone I have observed,) have shown that the natural effect of the advancing year is gradually to transform ice, solid and apparently homogeneous, into an aggregation of these irregular prismatic crystals, standing in vertical juxtaposition, having few surfaces of contact, but touching rather at points and on edges, and kept in place at last, merely by want of room to fall asunder. Until this change has somewhat advanced, the cohesive strength of ice of considerable thickness is still adequate to sustain the weight and shock of the travel it had borne during the winter, but becoming less and less coherent, by the growing isolation of the prisms, or more and more "rotten," as the phrase is, though retaining nearly all its thickness, the ice will at last scarcely support a small weight, though bearing upon a large surface—the foot of man easily breaking through, and very slight resistance being made to the point of a cane.

Before describing the peculiar preliminary process by which ice is brought to this condition, it may be well to follow out the steps by which the striking phenomenon of the sudden disappearance, by melting, of vast fields of thick ice is accomplished. The final forces of dissolution will vary somewhat with circumstances, but in all cases where the ice has been, so to speak, duly prepared, nothing is wanting to a quick disappearance, but a disruption of the few remaining surfaces of contact in the prismatic assemblage. If this be not abruptly effected by undulations in the field of ice, solution will continue to erode the sides of the constituent prisms, until, being no longer in contact, or adequately sustained laterally, each will drop into the position in the water below, required by the place of its own centre of gravity—that is to say, it will lie upon its side, exposing large surfaces to the action of the warm water. It is easy to see that this will occur, if not simultaneously, with all the prisms, in rapid succession.

But the effects, in the instance that first drew my attention, were the results of violence, causing the greater surprise by suddenly bringing about what, according to the calm process above indicated, would have been postponed for many days.

The condition of the ice on Lake Champlain on the day in April before mentioned, being a mere aggregation of vertical prismatic crystals, cohering only at points and along edges and narrow surfaces, as shown next morning by fragments on the shore, it could oppose little resistance to waves raised by the wind

of the following night. These acting first upon the edges of the air-holes and open spaces between the ice and the shore, caused slight undulations then in the ice itself, and the consequent pulling apart of the feebly cohering prisms, so that, the water surfaces being thereby enlarged, a short time only was necessary for the waves, increasing in altitude and force with the enlarging water surfaces, to send their undulations far before them under the yielding ice. The prisms falling upon their sides, all more or less immersed, affording now large surfaces to the solvent action of water above the melting temperature, and stirred about by the waves, were quickly dissolved. It is not easy to say in how short a time, under such circumstances, the great transformation would be wrought, but there ought to be no surprise that all was accomplished in the eight or ten hours of a spring night.

The preliminary process, before alluded to, of the conversion of masses of solid ice into an aggregation of vertical prisms by partial solution must be dependent on the fact that the law of crystallization in that substance yields prisms with vertical axes. That this is the law is indicated by cleavage as well as by solution; for while this is easy and free in planes perpendicular to the upper surface, it is said, truly I believe, not to be attainable in directions oblique or parallel thereto. Beyond this general fact of a vertical arrangement of prisms it is not necessary to go for elucidation of our subject, even if I could give minute specifications as to the crystallization of ice. I am not aware, indeed, that this question in crystallography, interesting as it might prove, has been very thoroughly investigated; but however that may be, we have demonstrated to us by the natural process of solution, that ice formed as in the case before us, however solid and homogeneous in appearance, contains a hidden array of crystalline prisms. So much is certain; and this, for the present, is enough on that point. May we not farther assume, that in the process of arrangement about the axes of these prisms, as they are projected downwards into the freezing water, the particles of water, in obeying the law of crystallization, crowd out, radially, the portions of air that would otherwise interfere with their just disposition as ice; and that, at last, this air, by accumulation in spaces between the prisms, suffices to prevent further obedience to the symmetrical principle, causing in these spaces, a confused and porous crystallization peculiarly favorable to the action of a solvent? Whether this be the precise cause or not, a condition favorable to dissolution certainly exists in the irregular spaces between the prisms, as we see by the particulars before given.

The process of Daniel for bringing to view the innate crystallization of apparently amorphous masses—namely, submitting

them to the action of a solution of the same substance, so nearly saturated as to exercise solvent power only when the solidification is imperfect—seems to afford a close analogy to that followed by nature, in preparing ice for quick dissolution.

The natural action seems to be this. The early rains of spring throw upon the surface, and by the tributaries, pour under the fields of ice frequent supplies of water, at a temperature melting even at first, and rising with the progress of the year. This warm underlying water, acting chiefly on the porous spaces between the prisms, dissolves them out to the full depth to which the ice is immersed, and perhaps still farther, by capillary action. At the same time, the spongy ice, formed upon the upper surface by melted and refrozen snow, affords warm water, by melting and percolation, to affect similarly the porous spaces between the tops of the prisms.

In this way, during the considerable period intervening between the first spring rains and the final breaking up of the lake, the solid ice is transformed into the condition necessary to a sudden dissolution.

We may assume, indeed, that the solvent action begins on the lower surface, about the time the accretion, by farther freezing, ceases; that it proceeds very slowly, so long as the temperature of the water remains below that of the greatest density, and of course that it goes on more rapidly as the water is lifted above that temperature by the growing warmth of spring.

I regret that I did not take the temperature of the water in the morning after the disappearance of the ice; but on this point I may add to what is said above, that the spring was then well forward, all, or nearly all, the snow had melted from the fields; the early rains and melted snows had for some time been raising the lake, which was then nearly at its greatest height. It was this rise in the lake that had spread a margin of water *that did not freeze* between the great field of ice and the shore. The inference from all the circumstances, that the temperature of the water at the time of disruption, and for some time previous, was not only above the melting point, but also above that of maximum density, seems to me unavoidable.

I may here be permitted to mention another matter connected with fields of lake-ice that has excited some wonder, namely, the movement towards the shore of boulders, sometimes quite large. The process which must have occurred to intelligent observers, and has probably been heretofore explained, seems to be this: after the rising of the water has supplied an unfrozen margin, a strong wind will sometimes cause the whole field to move until its edge meets adequate resistance upon the shore, all boulders encountered in the way, being pushed before it, into an array upon the shore that accurately marks the extent of the

invasion. These lines of boulders are to be seen in many places, registering accurately, not the work of the preceding year, but the greatest effort of any previous year.

The circumstances of some deep-lying boulders may be such that they are rarely embraced, acted on, or moved, and such may long, by fits, continue to be erratic, though finally to join the general shore parade.

The force of these moving fields is very great, even when the decomposing process is much advanced. I have seen a timber wharf, which was about thirty feet square, ten or fourteen feet high, and filled solidly with earth and stones, shoved along the bottom about thirty feet, by a single continuous push of a great field of ice just ready to be resolved into its prismatic elements. The motion was very slow, only to be seen, indeed, by close observation, while the ice was broken at the edge of contact into innumerable fragments, piling themselves, with a tinkling sound, high upon the wharf and following ice.

A simple and effectual guard against this danger to wharf or pier has been found to be, the giving to the exposed face a certain talus (about one of base to two of height, I think), which turns the ice upwards to the top of the structure, where its fragments accumulate, sometimes to a considerable height. This easy diversion of so great a force is due, of course, to the peculiar crystalline structure of the ice, the degree to which it has been decomposed, and the consequent brittleness against a transverse strain. Should there be an unfrozen margin to permit this motion of large fields of ice, before the solution of continuity in the crystalline arrangement, nothing but the solid earth could stand before it.

These remarks have extended further than I intended, and I fear much beyond what was required by the state of knowledge on the subject. But I venture, nevertheless, in reference to the first portion of these remarks, one further observation—namely, that nature seems to have especially provided, in the structure of these wintry coverings of water surfaces, for their prompt removal, when their existence would retard the advancing year.

ART. XL.—*On some Reactions of the Salts of Lime and Magnesia, and on the Formation of Gypsums and Magnesian Rocks;* by T. STERRY HUNT, F.R.S., of the Geol. Survey of Canada. (Continued from this vol., p. 187.)

IV.

Facts in the history of Gypsums, Dolomites, Magnesites and Limestones.

43. The gypsums found in nature may be divided into two classes, those directly deposited from water, and those produced by the alteration of beds of limestone. To the latter division belong the gypsums found in the vicinity of solfataras, where, as Dumas has shown, the slow oxydation of moist sulphuretted hydrogen gives rise to sulphuric acid, which transforms beds of carbonate into hydrated sulphate of lime. We must equally refer to the same class those gypsums which are formed among calcareous rocks by the action of waters containing free sulphuric acid. Such a process I have long since described in Western Canada, where numerous springs containing besides sulphates of lime, magnesia, oxyd of iron, alumina, and sulphuretted hydrogen, three or four thousandths of free sulphuric acid, rise through Upper Silurian strata, in the calcareous portions of which they sometimes give rise to masses of gypsum.

Bischof (*Chem. Geology*, i, 418), who does not appear to have seen my analyses of these acid waters, rejects my view of the epigenic origin of these masses of gypsum, although it will be apparent to every one who examines the facts, that the action of such waters upon calcareous strata must give rise to sulphate of lime. I do not however confound these recently formed masses of sulphate of lime with the older gypsums, which associated with dolomites, sea-salt and sulphur, are abundant in the Saliferous or Onondaga salt group of the same region.—(*Am. Jour. Sci.*, [2], vii, 175; *Report Geol. Survey*, 1848, 150; *Comptes Rendus de l'Acad.*, 1855, xl, 1348.)

These acid waters which make their appearance in an almost undisturbed region, I conceive to have their origin in deeply buried strata, where gypsum or other sulphates may be undergoing decomposition by the action of water and silica at an elevated temperature, a process analogous to that which gives rise to exhalations of carbonic acid gas.

44. Waters containing free sulphuric acid or ferric or aluminous sulphate, may by flowing into basins where carbonate of lime is present, give rise to solutions of sulphate of lime, and the evaporation of these, of sea-water or other gypseous solutions must give rise to deposits of sulphate of lime, which will

belong to the first division mentioned above. These modes of formation however do not account for an important fact in the history of most stratified gypsums, which is that of their almost constant association with carbonate of magnesia generally in the form of magnesian limestone. Beds of dolomite are often interstratified with or include beds or masses of gypsum, while dolomite and carbonate of magnesia are sometimes found imbedded in gypsum or anhydrite. For a description of the magnesite which is disseminated in the gypsum of Salzburg, see Dufrénoy, *Minéralogie*, 2d ed., ii, 424. Small masses of compact and crystalline gypsum, occasionally associated with crystals of calcite and quartz, abound in some of the dolomite beds of the so-called Calciferous sandrock in Canada, and crystallized gypsum and anhydrite, together with sulphates of baryta and strontia, and fluor spar, occur in geodes in the magnesian limestone of Niagara. The anhydrous sulphate of lime not only forms beds by itself but is often met with disseminated in masses, grains or crystals through beds of gypsum, and even interstratified with it, as in the south of France, in the Hartz, Switzerland, and in Nova Scotia, as described by Mr. Dawson. (*Acadian Geology*, 225.) The conversion of beds of anhydrite into gypsum by the absorption of water, and the attendant phenomena, have been described by Charpentier.

45. Both the hydrous and anhydrous sulphate sometimes form the cement of conglomerates or breccias, which enclose flints, fragments of shale and of limestone, as at Pomarance in Tuscany, (Scarabelli, *Bull. Soc. Géol. de France*, [2], xi, 346,) and also at Bex, where the cement of the conglomerate is a granular anhydrite (Charpentier, *Ibid.*, [2], xii, 546).

Gypsums moreover often include clay and sand, and sometimes contain a considerable admixture of carbonate of lime, which in those of Aix, according to Coquand, amounts to eight per cent. The gypsums of Montmartre also contain, according to Delesse, besides some clay and sand, and several hundredths of carbonate of lime, not less than three per cent of soluble silica intermixed. Silica in the form of flint or chert is sometimes found in concretions with gypsum; thus in the miocene clays near Bologna in Italy, flints are met with associated with sulphates of lime, of baryta and strontia, together with pyrites and sulphur. Masses of sulphate of strontia are likewise found in clays with the gypsums of Montmartre, and the association of sulphate of strontia with the sulphur, gypsum and rock salt of Sicily is well known. The gypsums of Madrid, which occur in tertiary clays, are according to Casiano de Prado, accompanied by beds of chert and of magnesite (*Bull. Soc. Géol. de France*, [2], xi, 334).

Besides the rock salt which so often occurs with gypsum, we may here recall its frequent association with the sulphates of soda and magnesia, both of which are found in very many places imbedded in gypsum, or intermingled with rock-salt or with the associated clays. (Bischof, *Chem. Geology*, ii, 421–431.) Large deposits of both of these sulphates occur with gypsum and rock-salt in Spain; in Nova Scotia also sulphate of soda is found in gypsum with boro-calcite, an association worthy of notice from the occurrence of boracite, both crystallized and massive (stassfurthite) with gypsums in Germany.—(How, *Am. Jour. of Science*, [2], xxiv, 230.)

46. The gypsums of the class which we are now describing appear in every geological period. To these apparently belong the masses of gypsum and anhydrite, which at Fahlun are associated with dolomite and serpentine in the chloritic bands of the oldest crystalline rocks of Scandinavia, the probable equivalents of the Laurentian system of North America. On this continent the oldest known gypsums are those already mentioned as occurring near the base of the palæozoic series, and in what is called by the geologists of New York the Calciferous sandrock. As we ascend the series gypsum is occasionally met with in the Clinton and Niagara groups, until we reach the Onondaga salt-group in the Upper Silurian rocks of Canada and New York, which contains great deposits of dolomite and gypsum, occasionally accompanied by sulphur. The gypsums, anhydrites, and brine springs of Nova Scotia belong to the Carboniferous series, while the frequent recurrence of gypsum in Europe through all the higher rocks up to the Miocene inclusive, is too well known to require notice.

47. The so-called primitive gypsums and anhydrites, which in the Alps and Pyrennees occur interstratified with crystalline schists, are now known to belong to altered secondary strata. These gypsums enclose many crystalline minerals, such as talc, mica, epidote, hornblende, dipyre, beryl, quartz, hematite, blende and pyrites. At Saurat in the Pyrennees many of these minerals appear in the vicinity of a mass of granite which penetrates and alters both fossiliferous limestone and gypsum. The latter becomes mingled with and finally passes into limestone. (Coquand, *Bull. Soc. Géol. de France*, [1], xii, 345.) In Algiers, where gypsum is associated with crystalline limestone, gneiss, amphibolite and serpentine, small crystals of beryl are found disseminated alike through the limestone and the gypsum. Some of the gypsums of the Hartz, according to Frapolli, contain nodules of a silicate of magnesia colored by carbonaceous matter, and having the softness and the chemical composition of steatite.—(*Ibid.*, [2], iv, 832.)

48. The marine origin of the greater number of gypsiferous formations is evident both from the accompanying rock salt and the associated fossils, but certain gypsums (as well as certain dolomites,) have evidently been deposited in fresh-water basins. A gypsum from Asia Minor examined by Ehrenberg contains a great number of fresh-water polygastric infusoria, and beds of gypsum occur in the lacustrine basins of Aix and of Auvergne; the gypsiferous strata of the Paris basin are also regarded as of fresh-water origin.

49. Besides the magnesian limestones of gypsiferous strata great deposits of dolomite occur in the rocks of every geological period. I have long since described the dolomites which form extensive beds, often associated with ophiolites and with crystalline limestones, in the Laurentian system in Canada. Great portions of the palæozoic limestones of North America are magnesian, especially in the valley of the Mississippi,* while deposits of dolomites are found in Europe alike in the Permian, Triassic, Jurassic, and Tertiary strata. Mr. Dana has even described as of recent formation a dolomite from the coral island of Matea, examined by Silliman and myself.—(*Am. Journal of Science*, [2], xix, 429.)

50. The mechanical conditions of these magnesian limestones vary greatly; they are sometimes made up of crystalline grains of dolomite, which are strongly coherent, or more rarely form a loose sand. Not unfrequently the magnesian limestones are concretionary in their structure, and may be oolitic or botryoidal. The action of the concreting force has sometimes obliterated the marks of stratification. The porous or cavernous structure of many dolomites is also to be remarked.

* For the following facts with regard to the dolomites of the palæozoic rocks of the Mississippi valley, I am indebted to Prof. James Hall of Albany. We have there in ascending order:

1st. The so-called *Lower Magnesian limestone*, which is regarded as the equivalent of the Calciferous Sandrock, and is from 200 to 250 feet in thickness. It is the lead-bearing rock of Missouri, and probably contains the cobalt ores of that region.

2d. The *Galena limestone*, consisting of about 250 feet of dolomite interposed between the Trenton and the Hudson River groups. It is the lead-bearing rock of Iowa, Wisconsin and Illinois.

3d. The *Niagara limestone*, also dolomitic, about 250 feet in thickness, and sometimes holding galena and blende.

4th. The *Leclaire* or *Galt limestone*, a dolomitic formation interposed between the last and the Onondaga Salt Group. It attains upon the Mississippi a thickness of 500 feet, but thins out to the eastward.

5th. The magnesian limestones of the *Onondaga salt group*, 100 feet thick.

6th. A dolomitic deposit in the upper part of the Carboniferous series.

The formation No. 1, although generally regarded as the equivalent of the Calciferous sandrock, is perhaps the representative of the Chazy limestone, which on Lake Huron is sometimes a pure dolomite, and on the island of Montreal includes thin magnesian beds. The Calciferous sandrock itself, throughout Lower Canada, includes extensive beds of dolomite, and the Hudson River group is characterized by beds of dolomite and of magnesite.

Magnesian limestones often contain large admixtures of clay and sand; dolomite is not unfrequently the cement of breccias or conglomerates, as in the well-known conglomerate of the Permian system in England. Concretionary masses of dolomite sometimes occur in these aggregates, and in the Permian rocks of the Vosges are found in beds of a sandy clay, itself occasionally cemented by dolomite.

I have elsewhere described two remarkable dolomitic conglomerates from the palæozoic rocks of Canada. The first of these belongs to the upper portion of the Hudson River group, and is conspicuously seen at Pointe Levis and on the island of Orleans. The associated rocks are there graptolitic shales, sandstones and fossiliferous limestones, together with great masses of a greenish or grayish-white subtranslucent compact concretionary limestone. This is without distinct marks of stratification, exhibits no trace of organic remains under the microscope, and has all the characters of a travertine or calcareous sinter. Interstratified with this last are beds of bituminous yellow-weathering dolomite, containing carbonate of iron, and always intermixed with more or less sand or clay or both; the clay in one specimen amounted to fifty per cent, while another quartzose variety gave carbonate of lime 53·04, carbonate of magnesia 31·96, carbonate of iron 5·80, silicious sand 8·80=99·60. The latter is a friable crystalline rock, showing in its fracture broad surfaces of cleavage, like the crystals of Fontainebleau sandstone. These dolomites, which contain no fossils, are occasionally traversed by veins of quartz and calcareous spar, or contain small masses of the latter mineral, apparently filling cavities. They are interstratified alike with the travertines and with the fossiliferous limestones, sometimes in large beds, and at other times in lenticular masses or in layers of a few lines in thickness separating masses of the travertine.

The conglomerates of this series inclose in a paste of ferriferous dolomite, grains and rounded fragments of limestone, often having the characters of the associated travertine, together with fragments of quartz and argillite, and small masses of a nearly pure yellowish crystalline dolomite; these are perhaps concretionary in their origin and not imbedded fragments. Other beds of a similar conglomerate occur in the same series having a cement of pure carbonate of lime, and the travertine itself often incloses grains of sand.—(*Geol. Surv. Canada; Report*, 1853–56, p. 465.)

The other conglomerate to be noticed occurs on the islands of Montreal, St. Helens, and several other localities in the neighborhood, and belongs to small detached patches of the Lower Helderberg series, left after denudation, which repose unconformably alike on Lower Silurian and Laurentian rocks. In

some localities they enclose the peculiar feldspars of the latter, in others the fossiliferous limestones, shales, sandstones and cherts of the former series, while in others still the principal elements are black augite, mica and olivine, derived from the igneous rocks which in this vicinity have broken through the Lower Silurian series. These conglomerates, which are remarkable for their great coherence, have a greenish, bluish or grayish yellow-weathering base, and contain much carbonate of iron. The soluble portion of a specimen from St. Helens was equal to 46·0 per cent, and consisted of carbonate of lime 57·8, carbonate of magnesia 16·4, carbonate of iron 25·8=100·0. In one instance these yellow-weathering beds of conglomerate are associated with others of which the cement remains white on the exposed surfaces, effervesces freely with acids, and is pure carbonate of lime. —(*Ibid.*, 1857, 201.)

51. Dolomite also occurs filling up fissures and cavities in other rocks, as in the case of pearl-spar in geodes and veins. The black and yellow marble from northern Italy, known under the name of Portor, and belonging according to Savi, to the Neocomian formation, is composed, by my analysis, of a black, nearly pure limestone containing only one-hundredth of carbonate of magnesia, penetrated by veins of ferriferous dolomite, which gave me 35·5 p. c. of carbonate of magnesia, and 4·6 of insoluble silicious matter, the residue being carbonate of lime and a little carbonate of iron. The veins of magnesian carbonate sometimes give to the Portor the aspect of a breccia.

52. Examples of the apparent infiltration of dolomite occur in black bituminous limestones at Montreal and Ottawa belonging both to the Trenton and Chazy divisions. These limestones, which contain only traces of magnesia, enclose casts of the interior of *Orthoceras, Murchisonia* and *Pleurotomaria*, consisting of a gray crystalline dolomite, weathering reddish, and appearing in high relief upon exposed surfaces of the limestone. In both localities the limestones are traversed by thin irregular veins of a similar dolomite, which communicate with the casts. By the action of dilute hydrochloric acid the limestone matrix is dissolved, and it is seen that the cavity of the fossil is in many cases only partially occupied by dolomite; that portion which is uppermost in the stratum being often filled with carbonate of lime to the extent of one-third or one-fourth, but in other specimens the whole cast is of dolomite. In some of the larger casts there are drusy cavities lined with crystallized dolomite and occasionally containing prisms of quartz. The analysis of a fragment of the cast of an *Orthoceras* from the Trenton limestone at Ottawa, gave me carbonate of lime 56·00, carbonate of magnesia 37·80, carbonate of iron 5·95=99·75. The surrounding limestone, which was compact, bluish-gray, and bituminous, con-

tained 3·9 p. c. of clay and sand; its solution gave 0·6 p. c. of oxyd of iron with alumina, but no magnesia. Similar examples of fossils replaced by dolomite occur in gray limestones associated with the travertines and dolomites of Pointe Levis (§ 50).

53. Magnesian limestones are very frequently destitute of organic remains; in some cases however they may contain calcareous fossils, as in the Niagara limestone at Dudswell, where corals of the genera *Cyathophyllum*, *Porites* and *Favosites*, composed of pure carbonate of lime, and generally bluish-black in color, are imbedded in a yellow ferriferous magnesian limestone which contains an excess of carbonate of lime. This limestone gave by analysis carbonate of lime 56·60, carbonate of magnesia 11·76, carbonate of iron 3·23, insoluble quartz sand 26·72= 98·31. The portion soluble in cold dilute acetic acid was carbonate of lime with four per cent of carbonate of magnesia and a trace of iron, and the residue when digested with dilute hydrochloric acid left 52·0 p. c. of sand and pyrites; the dissolved part consisting of carbonate of lime 51·75, carbonate of magnesia 35·73, carbonate of iron 12·52=100·00.

In the magnesian limestone of Galt in western Canada, which is a pure crystalline dolomite, there are numerous casts of bivalve molluscs, the shells of which were evidently removed by solution after they had been filled and enveloped by the dolomitic matrix, since the walls of the cavities once occupied by the shells of a large bivalve, *Megalomus Canadensis*, retain the markings of the inner and outer surfaces of the shell. Similar moulds of *Ophileta compacta* are abundant in the blue dolomite of Beauharnois, which belongs to the Calciferous sandrock; in a dolomite of the same geological formation from the Mingan islands, the shells of *Ophileta*, *Maclurea* and *Scaphites* are replaced by silica.

In some portions of the Galt formation fragments of encrinal columns are found replaced by dolomite, which is only distinguished by a little difference of color from the matrix. It would appear in this case as if the calcareous fossil having been first removed by solution (§ 30) the cavity had been subsequently filled with dolomite as in the casts found in the Ottawa and Montreal limestones (§ 52).

54. Although dolomites not unfrequently form by themselves masses of great thickness, as in the Jurassic formation of the Tyrol and the palæozoic rocks of the west, they are often interstratified in an intimate manner with pure limestones. Such is the case with the ferriferous dolomites already noticed in describing the dolomitic conglomerates and travertines of Pointe Levis (§ 50). In the Chazy limestone of Montreal, thin irregular layers of reddish ferriferous dolomite, themselves filled with encrinal columns, are interposed between beds of fossiliferous limestone.

The magnesian layers being pulverulent, the encrinal columns, which are pure carbonate of lime, are easily separated from their matrix, which gave me carbonate of lime 40·95, carbonate of magnesia 24·19, carbonate of iron 27·03, silicious sand without alumina 9·01=101·18; the iron was in part as peroxyd. The bluish crystalline limestone distant an inch from the magnesian layer gave 18·4 p. c. of white insoluble residue and 1·09 p. c. of carbonate of magnesia.

In these strata we sometimes meet with similar reddish pulverulent layers which contain no carbonate of magnesia, but are composed of carbonate of lime with a large amount of peroxyd of iron; such a mixture in one instance forms the cement of a breccia of fragments of the blue limestone; it was perhaps at one time a double carbonate of lime and iron.

The thin beds of dolomite above described are closely associated with those holding the dolomitic casts of orthoceratites already noticed; these were enclosed in a nearly black compact limestone, which during its solution in hydrochloric acid evolved traces of sulphuretted hydrogen. The residue contained a little iron pyrites which was removed by nitric acid; it was black from carbonaceous matter, but became white by ignition in the air, and was an impalpable powder, equal to 12·8 p. c. of the rock. Dilute soda ley removed from it 9·5 p. c. of its weight of soluble silica, and the residue had nearly the composition of a feldspar. It gave me, silica 73·02, alumina 18·31, lime 0·93, magnesia 0·87, potash 5·55, soda 0·89=99·57.

The fossiliferous yellow magnesian limestones of Dudswell (§ 53) are in like manner interstratified with beds of gray crystalline limestone containing 6·3 p. c. of sand and only 1·3 p. c. of carbonate of magnesia. These beds having been much disturbed and broken, the interstices appear to have been filled up with portions of the yellow magnesian paste giving rise to a marble which in some portions resembles the so-called Portor, (§ 51).

55. We see from the above examples that dolomites may occur interstratified both with limestones of organic origin and with others which are evidently chemical deposits. Allied to these latter are certain porous tufaceous beds of carbonate of lime which sometimes accompany dolomite. Such tufas occur alternating with the dolomites and gypsiferous marls of the Onondaga salt group. A similar layer of cellular calcareous tufa, free from magnesia, I have observed immediately covering a deposit of crystalline incoherent dolomite in the Eocene series at Pont St. Maxence in France.—(See also Damour, *Bull. Soc. Géol. de France*, [2], xiii, 67.)

56. The chemical constitution of the rocks containing carbonate of magnesia now demands our consideration. Pure dolomite

is well known to consist of equivalents of carbonate of lime and magnesia corresponding to 45·65 parts of the one to 54·35 of the other, and many magnesian limestones have this composition, or contain beside only mechanical impurities, such as sand and clay. Others with an excess of carbonate of lime are shown by the method of Karsten to be mixtures of dolomite with carbonate of lime, which is readily separated by the solvent action of cold dilute acetic acid (§ 28, § 53). The same chemist however found in clefts and fissures of the gypsiferous rocks of Luneberg and elsewhere, carbonates of lime and magnesia mingled with clay, from which dilute acetic or muriatic acid removed the whole of the lime, leaving a residue of from 4·0 to 68·0 p. c. of magnesian carbonate which had evidently been mechanically intermingled with the carbonate of lime. (Bischof, *Lehrbuch*, ii, 1161.) Since the presence of sulphate of lime appears to prevent in a great measure the union of the two carbonates (§ 31), we might suppose that the association of gypsum with these magnesian clays had in some way hindered the formation of the double carbonate. The free carbonate of lime which they contain is however probably epigenic and produced by the decomposition of a portion of the magnesite by the infiltration of dissolved gypsum.

Carbonate of iron often replaces a part of the magnesian carbonate in dolomites, which also sometimes contain carbonate of manganese, and even carbonates of zinc, cobalt and lead. It not unfrequently happens that the sum of the other carbonates in these ferruginous dolomites is more than equivalent to the carbonate of lime. Such is the case with the dolomitic conglomerate of St. Helens (§ 50).

The dolomites of the Hudson River group in eastern Canada are very often associated with copper, nickel, titanium, chrome and manganese. A grayish granular dolomite from Sutton, which contains disseminated chlorite and crystals of magnetite, weathers blackish-brown from the presence of manganese. The foreign minerals are arranged in bands, and layers of the dolomite an inch or two in thickness are apparently free from admixture. The analysis of such a portion gave me, carbonate of lime 40·10, carbonate of magnesia 20·20, carbonate of iron 10·65, carbonate of manganese 7·65, insoluble, chiefly quartz, 21·45=100·00. The associated crystals of magnetite contained no trace of manganese.*

* Carbonate of manganese is frequently met with in the rocks of this geological series, causing them to weather brownish-black. I have described an impure chloritic limestone of this kind from Granby (Canada East), which contains besides protoxyds of manganese and iron, portions of chrome, nickel and titanium. (Report, 1853-56, 474, and this Journal, [2], xxvi, 238.) Rogers has in like manner noticed the occurrence of a large proportion of protoxyd of manganese in the olive colored slates of the Lower Silurian series in Pennsylvania, and to the decomposition of

57. Magnesian limestones containing an excess of carbonate of magnesia are not uncommon; one from the muschelkalk of Thuringia gave to Senft, carbonate of lime 42·9, carbonate of magnesia 55·4, besides 2·7 of carbonate of iron =101·0. A lacustrine dolomite from the brown-coal formation near Giessen contains, according to Knapp, carbonate of lime 42·80, carbonate of magnesia 49·63, besides oxyd of iron and impurities, and a specimen from the Lower Magnesian limestone from Lake Superior gave to Whitney, carbonate of lime 25·28, and carbonate of magnesia 32·57, besides 37·0 of sand and a little iron and alumina. Similar magnesian rocks are described by Alberti as occurring in the variegated marls of the *keuper* or upper part of the Triassic system in Germany. A tender greenish schistose marl from Tubingen effervesced very slightly with acids, and gave for 100·00 parts, carbonate of lime 14·56, carbonate of magnesia 19·10, the remainder being clay with a little iron-oxyd. (Senft, *Die Felsarten*, 134.) Von Bibra has described similar magnesian marls from the muschelkalk in Franconia (Bischof, *Lehrbuch*, ii, 1158), and Gueymard, from the gypsums of Roquevaire in Provence. The bituminous salt-clays (*salzthon*) which occur with gypsum and rock salt, when freed by washing from soluble salts, contain according to Schafhautl, carbonates of magnesia and iron often with very little carbonate of lime, the argillaceous matter varying from 12·0 to 70·0 p. c. (Bischof, *Lehrbuch*, ii, 1725.) To these clays are perhaps related the magnesian marls examined by Karsten (§ 56). Völckel has described a dark gray rock interstratified with limestone from the *keuper* near Solothurn, and consisting of carbonate of magnesia 54·55, carbonate of iron 33·94, carbonate of lime 0·67, with 10·81 of clay, water, etc. (*L. and K. Jahresbericht*, 1849, 581.)

58. Magnesian rocks allied to the last occur in the Hudson River group of eastern Canada, and were described by me several years since. In the township of Sutton, interstratified with dolomite, steatite and talco-quartzose strata, is a bed of green and white reddish-weathering crystalline rock, gneissoid in structure, and containing variable porportions of magnesian carbon-

such rocks correctly ascribes the origin of the deposits of peroxyd of manganese met with in that region. Beds of silicate of manganese, more or less intermingled with carbonates of manganese and lime, are interstratified with crystalline schists in various localities in New England. I may mention in this connection a compact massive carbonate of manganese which is said to occur in slates supposed to be of Silurian age, at Placentia Bay, Newfoundland, and which I received from Dr. J. W. Dawson. It is conchoidal in fracture, translucent on the edges, with a feeble waxy lustre; color fawn to pale chestnut-brown. H. 4·0. D. 3·25. It is penetrated and incrusted in part with crystalline peroxyd of manganese. Acids in the cold scarcely attack this mineral, but heated nitric acid dissolves it with effervescence, leaving a residue of 14·4 p. c. of silica, of which the greater part is soluble in a dilute alkaline solution. The analysis gave me besides 84·6 p. c. of carbonate of manganese, and traces of lime, iron and magnesia. (Report, 1857, 204.)

ate. A pure and nearly white fragment gave to hydrochloric acid, carbonate of magnesia 83·35, carbonate of iron 9·02, and left insoluble 8·03=100·40; while another specimen from the same mass contained, carbonate of magnesia 33·00, carbonate of iron 19·35, alumina 0·50, insoluble 45·90=98·70. In both cases the solution contained a little nickel, which occurs in the rock, in part at least, in the form of grains of nickeliferous pyrites. The insoluble portion is a silicate of alumina and alkalies, with a little magnesia, and appears to consist of a mixture of feldspar with a little mica and talc, the latter minerals being colored emerald-green by a small portion of oxyd of chrome.

In the township of Bolton there occurs a bed of magnesite many yards in breadth, interstratified between steatite on the one side, and an impure ophiolite passing into diorite, on the other. It is made up of brilliant cleavable grains of magnesian spar, bluish-gray or nearly white in color, and intermingled with others of white hyaline quartz, which sometimes forms small irregular veins. One of several analyses of this rock gave me, carbonate of magnesia 59·13, carbonate of iron 8·32, insoluble 32·20=99·65. In other specimens the proportion of carbonate of iron is a little greater, and traces of carbonate of lime are sometimes met with, while nickel is never wanting and sometimes coats the joints of the rock with a yellowish-green film of what appears to be a hydrocarbonate of nickel; the proportion of this metal determined upon a considerable quantity of the rock was found equal to about one-thousandth. The insoluble residue from this magnesite was greenish-gray in color, and gave by analysis 93·6 p. c. of silica, besides some alumina, 0·8 of alkalies, and traces of lime, magnesia, and oxyd of chrome, which gives an emerald-green color to some portions of the rock. I have already shown that nickel is rarely absent from the magnesian rocks of this region, where it is generally accompanied by chrome. These magnesites in powder do not perceptibly effervesce with cold hydrochloric acid, which however readily dissolves them with the aid of heat. The decomposition of the contained carbonate of iron renders their weathered surfaces reddish-brown and pulverulent.—(*Report*, 1853–56, p. 460.)

I have detected a quartzose magnesite closely resembling that of Bolton, containing nickel, and stained emerald-green by oxyd of chrome, among a collection of rocks brought from California by Mr. W. P. Blake, who also found a bed of nearly pure white compact carbonate of magnesia among the crystalline schists of that region. I may here recall the existence of beds of magnesite among argillites in Styria, and also in the ancient crystalline gneiss of Modum in Norway, where a crystalline magnesite is the gangue of crystals of serpentine and ilmenite.—(*Am. Jour. of Science,* [2], v, 389.)

59. The greater number of dolomites and magnesian rocks are shown by their fossils or by the nature of the associated strata to be of marine origin, but dolomites are also found in fresh-water deposits. Such is that with excess of magnesian carbonate from the brown-coal formation near Giessen (§ 57), and dolomites are said to occur with the lacustrine limestones of Dachingen near Ulm.—(Senft, *Die Felsarten*, 133.)

V.

On the mode of formation of the preceding rocks.

60. Having in the fourth division of this paper brought together the principal facts in the history of magnesian rocks, as well from the researches of others as from our own observations, we have seen that these rocks consist essentially of dolomite, mixed with carbonate of lime on the one hand, and with carbonates of magnesia and iron on the other, passing thus into magnesite. The frequent intermixtures of sand and clay and even of fragments of quartzite, argillite and limestone, clearly show their sedimentary origin, which is moreover rendered evident by the fact that they are often interstratified with pure limestones and even inclose calcareous corals; these facts exclude the idea of the formation of all such dolomites at least, by the alteration of deposits of carbonate of lime as supposed by Von Buch, Haidinger and Favre.

61. The dolomites of the Tyrol which Von Buch imagined to have been formed from the alteration of limestones by magnesian vapors evolved at the time of the ejection of certain melaphyres of that region, have been shown to be much more recent than these melaphyres, which according to Fournet are not intrusive but sedimentary rocks, probably of Carboniferous age, altered *in situ.* These metamorphosed strata are separated from the dolomites, which are Jurassic, by unaltered Triassic strata, including the muschelkalk and a conglomerate holding rolled fragments of the melaphyres.* (*Bull. Soc. Géol. de France*, [2], vi, 506–516.) In several other cases where dolomization was supposed to have been produced by the proximity of igneous rocks, Delesse and Delanouë have shown that the change had been limited to an alteration in the texture, and that there had been no addition of magnesia.

62. Favre supposes with Haidinger that magnesian solutions under heat and pressure have given rise to dolomites by decomposing beds of limestone with formation of carbonate of magnesia agreeably to the observations of Von Morlot and Marignac. (*Ibid.*, [2], vi, 318.) This hypothesis is evidently not applicable

* Bischof cites *Fournet, Histoire de la Dolomie*, 1847, but I have not been able to consult the work in the preparation of this paper.

to those magnesian limestones which include beds, fragments or organic remains of pure carbonate of lime. In any case we must suppose a long continued filtration of solutions of magnesian chlorid through the heated limestone under certain conditions which seem at least improbable.

63. The theory of the formation of magnesian sediments will be readily understood from the experiments which have been described in the earlier parts of this paper, but before proceeding to its consideration I wish to call attention to the results of the concentration by evaporation of natural waters in basins without an outlet. If such a basin contain sea-water, the gypsum, being insoluble in a saturated brine, will be entirely deposited before the crystallization of the sea-salt, and there will remain a liquid containing no lime-salts, but chlorids of sodium and magnesium with a large amount of sulphate of magnesia. Such are the waters of Lake Elton and many of the brine pools of the Russian steppes, while on the contrary the saturated brines of the Dead Sea and some other salt lakes contain little sulphate but abundance of chlorid of calcium, and if they are the residues of sea-water, have been modified by additions of this salt, which has converted the sulphate of magnesia into chlorid of magnesium and gypsum, the calcareous chlorid remaining in excess.

But while some of these saline lakes may be supposed to be basins of sea-water, modified by evaporation, either alone or conjoined with the influx of foreign saline matters, others were evidently once fresh-water lakes in which, the loss of water being equal to the supply, have gradually accumulated the soluble salts of all the rivers and springs flowing into the lake. We may arrive at some notion of the diverse natures of the different saline lakes which would be formed in this way if we suppose the waters of different European rivers to be subjected to evaporation under conditions like those of the salt lakes of Western Asia. In the waters of the Elbe and Thames chlorids greatly predominate (in the latter with gypsum), with small amounts of magnesian salts, and the evaporation of these waters would give rise to lakes containing a large proportion of common salt. In the Seine on the contrary, sulphate of lime predominates, while the waters of the Rhine, the Danube, the Arr and the Arve contain but small amounts of chlorids and large proportions of sulphates of lime and magnesia.

64. In other rivers we find alkaline salts; the Loire at Orleans, according to Deville, contains in 100,000 parts, 13·46 of solid matters, of which 35·0 p. c. is carbonate of lime, 30·0 p. c. silica, while two-thirds of the more soluble salts consist of carbonate of soda. In the waters of the Garonne, with as large a proportion of silica, and more carbonate of lime, the carbonate of soda equals one-fourth of the soluble salts, while 100,000 parts of the

water of the Ottawa, according to my analysis, contain 6·11 parts of solid matters, consisting of carbonate of lime 2·48, carbonate of magnesia 0·69, silica 2·06, sulphates and chlorids of potassium and sodium 0·47, and carbonate of soda 0·41. (*Report Geol. Survey of Canada*, 1853–56, 360, and *Philos. Mag.*, [4], xiii, 239.) Silica, although more abundant in alkaline river waters, which are chiefly derived from crystalline rocks, is not wanting in waters containing neutral earthy salts, like the Seine and the Rhone, of the solid matters of which, according to Deville, it forms respectively 10·0 and 13·0 p. c.—(*Ann. de Chem. et Phys.*, [3], xxiii, 32.)

The waters which rise from the Lower Silurian shales of the St. Lawrence valley are, as I have elsewhere shown, remarkable for the predominance of alkaline salts, which sometimes amount to one-thousandth, or more than one-half the solid matters present; these waters are distinguished from the river waters just mentioned by their comparatively small amount of silica and earthy carbonates, and by the presence of a notable proportion of borates.—(*Rep. Geol. Survey of Canada*, 1852, p. 165,—1853–56, p. 469, and *Proc. Royal Soc.*, *Phil. Mag.*, [4], xvi, 376.)

We may here refer to the strongly alkaline waters furnished by the artesian wells of Paris and London as evidences of the abundance of alkaline carbonates in natural waters, and to the springs of Vichy and Carlsbad, the latter of which, according to the calculations of Gilbert, furnish annually more than thirteen millions of pounds of carbonate of soda. The evaporation of these alkaline waters, whether rivers or springs, must give rise to natron lakes like Lake Van and those of the plains of Araxes, Lower Egypt, and Hungary.—(Bischof, *Lehrbuch*, ii, 1143.)

The carbonate of soda contained in these waters has its source in the decomposition of feldspathic minerals, and shows the continuance in our time of a process whose great activity in former geologic ages is attested, as I have elsewhere maintained, by vast accumulations of argillaceous sediments deprived of a large portion of their soda, and also by the carbonate of lime which by the intervention of carbonate of soda has been formed from the chlorid of calcium of the primeval ocean and deposited as limestone.

65. An indispensable condition for the precipitation of carbonate of magnesia is the absence of chlorid of calcium from the solutions, and this in the presence of excess of sulphates is attained simply by evaporating to the point where gypsum becomes insoluble. In nearly all river and spring waters bicarbonate of lime is present in a large proportion, and is often the most abundant salt. We have shown that when mingled with a solution containing sulphate of magnesia, it gives rise by double decomposition to bicarbonate of magnesia and sulphate of lime.

By the evaporation of such a solution, the latter salt, being the less soluble, is first deposited in the form of gypsum, while the magnesian carbonate is only separated after farther evaporation, when, provided the supply of bicarbonate of lime still continues, the two carbonates may fall down in a state of intermixture. In this way sediments will be formed containing the elements of dolomite or magnesite.

66. The solution of magnesian carbonate remaining after the deposition of the gypsum, possesses, as we have seen, the power of decomposing chlorid of calcium, and when deprived of a portion of its carbonic acid by evaporation, reacts in a similar manner with a solution of sulphate of lime (§ 5, § 23). In this way, an influx of sea-water into the basin from which gypsum, and perhaps a portion of magnesian carbonate has already been deposited, would give rise to a precipitate of carbonate of lime, like the tufaceous limestones, whose occurrence with gypsum and dolomites has been already noticed. In basins which, like the salt lagoons of Bessarabia on the shores of the Black Sea, receive occasional additions of sea-water, and deposit every summer large amounts of salt, (Bischof, *Lehrbuch*, ii, 1717,) the influx of waters containing bicarbonate of lime would give rise to the formation of beds of gypsum, alternating with dolomites or magnesian marls and rock salt.

67. We have already referred to the analyses of certain rivers, in which the sulphates are more abundant than the chlorids. Thus, in the Rhine, near Bonn, according to Bischof, we have for 100,000 parts of the water, 17·08 of solid matters, of which 1·23 are sulphate of lime, 1·81 sulphate of magnesia, with only 1·45 of chlorid and 8·37 of carbonate of lime; in the Danube near Vienna, the predominance of sulphates is still more marked. The waters of the Arve, in the month of February, gave to Tingry, for 100,000 parts, 24·5 of solid matters, of which 6·5 were sulphate of lime, 6·2 sulphate of magnesia, and 8·3 carbonate of lime, with only 1·5 of chlorids. Now, as in river waters there is always present an excess of carbonic acid, and as bicarbonate of lime and sulphate of magnesia in solution are mutually decomposed, these waters, which are to be regarded as solutions of sulphate of lime and bicarbonate of magnesia, (§ 18) would, by their evaporation, yield gypsum and magnesian carbonate, which would appear as portions of a fresh-water formation, like those of Aix and Auvergne.

The decomposition of soluble sulphates by bicarbonates of baryta and strontia, will explain the formation of heavy spar and celestine, and their frequent association with gypsiferous rocks.

68. As to the native sulphur which is often associated both with epigenic and sedimentary gypsums, it has doubtless in every case been formed as Breislak long since indicated, by the

decomposition of sulphuretted hydrogen. It is well known that alkaline and earthy sulphates are reduced to sulphurets by organic matters, with the aid of heat, or even at ordinary temperatures, in presence of water. To the decomposition of these sulphurets by water and carbonic acid, we are to ascribe not only the sulphuretted hydrogen of solfataras, which, by its oxydation under different conditions, gives rise either to free sulphur, or to sulphuric acid and to gypsum by epigenesis, but also the sulphuretted hydrogen which appears in springs and in stagnant waters, where the sulphur produced by the decomposition of the gas is often mingled with sedimentary gypsums.* (See Bischof, *Lehrbuch*, ii, 139–185.) This author has suggested the decomposition of chlorid of magnesium by alkaline or earthy sulphurets as a source of sulphuretted hydrogen and hydrate of magnesia, into which sulphuret of magnesium is readily resolved in the presence of water. (*Chem. Geology*, i, 16.) If a salt of calcium were present, this reaction could only take place in the absence of carbonic acid, for carbonate of magnesia is incompatible with chlorid of calcium. The direct reduction and decomposition of sulphate of magnesia by organic matter and carbonic acid may, however, yield sulphuretted hydrogen and carbonate of magnesia, and thus, in certain cases, give rise to magnesian sediments.

69. In the preceding sections, we have supposed the waters mingling with the solution of sulphate of magnesia to contain no other bicarbonate than that of lime, but bicarbonate of soda is often present in large proportion in natural waters, and the addition of this salt to sea-water or other solutions containing chlorids and sulphates of lime and magnesia, will, as we have seen, (§ 1) separate the lime as bicarbonate, and give rise to liquids, which, without being concentrated brines as in the previous case, will contain sulphate of magnesia, but no lime salts. A farther portion of bicarbonate of soda will produce bicarbonate of magnesia, by the evaporation of whose solutions as before, hydrated carbonate of magnesia would be deposited, mingled with the carbonate of lime which accompanies the alkaline salt, and in the case of the waters of alkaline springs, the compounds of iron, manganese, zinc, nickel, lead, copper, arsenic, chrome, and other metals, which springs of this kind still bring to the surface. In this way the metalliferous character of many dolomites is explained, as also the frequent association of metals, such as copper, nickel, cobalt, chrome and titanium, with serpentine, steatite, diallage, olivine, and other magnesian silicates, which owe their origin to the alteration of magnesian sediments such as we have described.

* On certain modes of decomposition of the sulphates, see Jacquemin, *Comptes Rendus*, June 14, 1858.

70. As the separation of magnesian carbonate from saline waters by the action of bicarbonate of soda does not suppose a very great degree of concentration, we may conceive this process to go on in basins where animal life exists, and thus explain the origin of fossiliferous magnesian limestones like those of the Dudswell (§ 53,) and the Silurian rocks of the western United States, whose fossils, as I am informed by Mr. James Hall of Albany, are generally such as indicate a shallow sea. To the intervention of carbonate of soda is I conceive to be referred the origin of all those dolomites which are not accompanied by gypsums, and which make up by far the larger part of the magnesian limestones; nor will the dolomites thus derived be necessarily marine, for the same reagent with waters like those of the Danube and Arve would give rise to dolomites and magnesites in fresh-water formations, which unlike those mentioned in § 67, would not be accompanied by gypsums.

71. To the first stage of the reaction between alkaline bicarbonates and sea water I am disposed to ascribe the formation of certain deposits of carbonate of lime which although included in fossiliferous formations, are unlike most of their associated limestones, not of organic origin, but have the characters of a chemical precipitate of nearly pure carbonate of lime, in which are often imbedded silicified shells and corals.* It is not perhaps easy in all cases to distinguish between such precipitates, which may assume a concretionary structure, (see on this ques-

* The large proportion of dissolved silica which many river waters contain (§ 64) appears in sedimentary deposits, not only replacing fossils and forming concretions and even beds of flint, chert and jasper, but also in a crystalline state, as is seen in the crystallized quartz often associated with these amorphous varieties, and in some beds of sandstone which are made up entirely of small crystals of quartz. Elie de Beaumont long since called attention to the crystalline nature of certain sandstones which as Daubrée has remarked, could not have been derived from the disintegration of any known rock, and Mr. J. Brainard at the meeting of the American Association for the Advancement of Science, held at Cleveland, insisted upon the crystalline character of the grains composing sandstones in Ohio, as evidence that these were chemical deposits. He however fell into the error of supposing that all sandstones and even quartzose conglomerates have had a like origin, while the latter and the greater part of the former are undoubtedly mechanical deposits from the ruins of pre-existing quartzose and granitic rocks.

These crystallized sands according to Daubrée, are met with in beds in the sandstone of the Vosges, the variegated sandstone (Triassic and Permian,) in the tertiary of the Paris basin and elsewhere. Other sands are made up of globules of calcedony, apparently like the crystallized sands a chemical deposit, and associated with oolitic iron ores in the lias, and with glauconite grains in the green-sand. (Daubrée *Recherches sur le Striage des Roches, etc.,* Ann. des Mines 1857, 6 livr.) We may here mention the so-called *gaize* from the green sand of the Ardennes, which gave to Sauvage 56·0 p. c. of amorphous soluble silica mixed with quartz sand and glauconite. (Bischof, *Lehrbuch,* i, 768–811.)

Maschke has shown that under certain conditions silica is soluble in about twenty-five parts of pure water; from this solution it separates by evaporation or by the addition of concentrated saline solutions in a form insoluble in water. (*Jour. für prakt. Chemie,* lxviii, 238.) In these reactions we have a key to the formation of silicious deposits.

tion Bischof, *Chem. Geology*, i. 428,) and those deposits which like travertines have been formed from subterranean springs. In neither case however, should they be confounded with the tufaceous limestones mentioned in § 63.

72. The union of the mingled carbonates of lime and magnesia to form dolomite, is attended with contraction, which in case the sediment was already somewhat consolidated, would give rise to fissures and cavities in the mass. Should the dolomitic strata be afterwards exposed to the action of infiltrating carbonated waters, the excess of carbonate of lime and any calcareous fossils would be removed, (§ 30,) leaving the mass still more porous, with only the moulds of the fossils. Insoluble however as it appears to be at ordinary temperatures, the filling up of such cavities both in magnesian and in pure limestones, not less than its deposition in veins and druses, indicates that dolomite is under certain conditions soluble.

The lowest temperature at which hydrous magnesian sediments may be transformed into magnesite and dolomite has yet to be determined. The requisite heat has however doubtless been attained by the accumulation of overlying sediments, in virtue of that law which causes the temperature to increase as we penetrate the earth's crust. This increase we may suppose with Mr. Hopkins to have been much more rapid in former epochs than at present.—(*Geol. Journal*, viii, 59, also Phillip's *Manual of Geology*, 609.)

Conclusions.

1. The action of solutions of bicarbonate of soda upon sea water separates in the first place the whole of the lime in the form of carbonate, and then gives rise to a solution of bicarbonate of magnesia, which by evaporation deposits hydrous magnesian carbonate.

2. The addition of solutions of bicarbonate of lime to sulphate of soda or sulphate of magnesia gives rise to bicarbonates of these bases, together with sulphate of lime, which latter may be thrown down by alcohol. By the evaporation of a solution containing bicarbonate of magnesia and sulphate of lime, either with or without sea salt, gypsum and hydrous carbonate of magnesia are successively deposited.

3. When the hydrous carbonate of magnesia is heated alone under pressure it is converted into magnesite, but if carbonate of lime be present, a double salt is formed which is dolomite.

4. Solutions of bicarbonate of magnesia decompose chlorid of calcium, and when deprived of their excess of carbonic acid by evaporation, even solutions of gypsum, with separation of carbonate of lime.

5. Dolomites, magnesites and magnesian marls, have had their origin in sediments of magnesian carbonate formed by the evaporation of solutions of bicarbonate of magnesia. These solutions have been produced by the action of bicarbonate of lime upon solutions of sulphate of magnesia, in which case gypsum is a subsidiary product; or by the decomposition of solutions of sulphate or chlorid of magnesium by the waters of rivers or springs containing bicarbonate of soda. The subsequent action of heat upon such magnesian sediments, either alone or mingled with carbonate of lime, has changed them into magnesite or dolomite.

ART. XLI.—*On Gallic and Gallhumic (Metagallic) acid;* by Dr. F. MAHLA, Ph.D., Chicago.

It is mentioned among the reactions of gallic acid in almost every handbook of chemistry, that its solution produces a deep bluish-black color with a solution of the salts of the sesquioxyd of iron, which disappears, when the solution is heated. As I have nowhere found an explanation of this fact, I have tried to investigate it by some experiments.

When the solutions of the sesquioxyd of iron and gallic acid are used in a diluted state, the resulting mixture appears only slightly colored, but if they are concentrated, it assumes after being heated to ebullition, a dark brown tint, and then causes black spots on the skin, which can be washed away only with the greatest difficulty. Such a solution might perhaps be used advantageously as a hair dye.

If the iron-solution was not added in too large proportion, liquid ammonia no longer precipitates hydrated sesquioxyd of iron, but the proto-sesquioxyd (black oxyd). A reduction takes place therefore, the oxygen transforming some of the carbon of the gallic acid into carbonic acid, which is freely evolved during the ebullition.

To a portion of gallic acid, dissolved in water and heated to ebullition, a solution of sesquichlorid of iron was carefully added in small quantities and the mixture heated again after each addition. This treatment was continued, until a drop of the solution mixed with a little water ceased to give the characteristic bluish-black precipitate of gallic acid with sesquichlorid of iron. A solution of carbonate of soda was then added in slight excess and the black precipitate separated by filtration. A portion of the filtered dark-brown liquor, after being exactly saturated with hydrochloric acid, deposited a voluminous black precipitate, which if dried, formed a black shining mass but when freshly

precipitated, was easily redissolved by free muriatic acid. Such a solution, containing but little free muriatic acid, produced black insoluble precipitates with limewater, with the different salts of lime and baryta, with sulphate of zinc and sulphate of copper. Another portion of the filtered liquor super-saturated with acetic acid, caused precipitates of a black color in solutions of acetate of lead and nitrate of silver. From the silver precipitate, metallic silver was soon separated.

The lead precipitate was carefully washed with distilled water, and after being dried in an air-bath at a temperature not exceeding 200° F. (94° C.) for ten hours, it was heated over a spirit lamp, until the organic matter was perfectly destroyed. The residue, consisting of a mixture of oxyd of lead and metallic lead, was treated with acetic acid, and from it the whole quantity of oxyd of lead was calculated.

1·052 gram. gave 0·662 of the mixture of PbO+Pb, which left after being treated with acetic acid 0·037 metallic lead, a quantity corresponding to 0·041 oxyd of lead. The acetic acid extracted 0·625 oxyd of lead, which quantity added to the above found 0·041 gives 0·666. This is equal to 63·30 per cent.

Gallhumic (metagallic) acid, which was detected by Pelouze in the residue of distillation, when gallic acid was suddenly heated to 480° F. (249° C.) shows the same reactions, and its lead salt, 2PbO, $C^{12}H^{3}O^{3}$, contains 63·04 per cent of the oxyd of lead. No doubt can therefore exist about the identity of Pelouze's acid and my product. Two equivalents of gallic acid are divided exactly into one equiv. of gallhumic, two equiv. of carbonic acid, and three equiv. of water:

$$C^{14}H^{6}O^{10} = \left\{ \begin{array}{l} C^{12}H^{3}O^{3} \\ C^{2}\quad O^{4} \\ \quad H^{3}O^{3} \\ \hline C^{14}H^{6}O^{10} \end{array} \right.$$

This origin of gallhumic acid forms another and interesting argument, that pyro-acids can be obtained otherwise than by the action of heat.

If some powdered "red precipitate" is added to a solution of gallic acid and heated over a spirit lamp, it is immediately reduced; gallic acid precipitates suboxyd of copper (red oxyd) in a solution of sulphate of copper; this reaction appears with the greatest facility if the solutions are heated together. It also reduces a cold solution of neutral chromate of potassa, producing the green sesquioxyd. The gallic acid is in each of these cases transformed into gallhumic acid. The action of these substances on gallic acid and the formation of the new product, is explained by assuming gallhumic acid to be only an intermediate product, the final result being carbonic acid and water.

ART. XLII.—*The Great Auroral Exhibition of August 28th to September 4th*, 1859.

ON the evening of August 28th, 1859, was commenced an exhibition of Auroral or Polar light which continued with varying intensity at different localities in North America, so far as is now known, up to September 4th. This auroral display is one of the most remarkable ever recorded in the United States; remarkable not only for the great extent of territory over which it was observed, but also for its duration, for the intensity of the illumination as well as the brilliancy of the colors, and the extreme rapidity of the changes. It was also equally remarkable for the magnetic disturbances which accompanied it, especially on the 2d and 3d of September. These electrical perturbations were recorded not only by the usual magnetic instruments, but over the whole system of telegraphic wires, especially in New England and the Canadas, the magnetic induction either greatly interfered with or prevented the working of the lines by the usual voltaic current, while in more than one case the north and south lines were worked during the daytime of September 3d solely by the atmospheric influence! This remarkable and novel phenomenon deserves and will receive special attention hereafter.

It appears from our own correspondence, and from the daily Journals, that the late display of the Aurora was witnessed from Cuba and Jamaica on the south, to an unknown distance beyond the Canadas on the north, and from Central Europe on the east, to California on the west. Doubtless we may expect to hear that it was seen over the entire northern hemisphere, and in some places as far south as lat. 20°.

Since the laws of this phenomenon are as yet but imperfectly understood, it is regarded as very important that the facts respecting the late grand exhibition should be carefully collected and placed on record, in the expectation that at some future day they may afford the basis for a complete and satisfactory theory of this meteor.

We now publish such original observations on this Aurora as have reached us in an authentic form, and we hope in future numbers of this Journal to present many other important data of the same description from different and distant parts of this and the other continent. We intend to present in the first place the *facts* of this exhibition divested of all theoretical considerations; and when all the materials have been collected we shall give such explanation of them as we are able. At present we put on record observations of the aurora and its attendant phenomena made at Lewiston, Me.; at Toronto, Canada West; at New Haven, Conn.; at West Point, N. Y.; at Bloomington,

Ind.; at Springhill, Ala.; at Jefferson Co., Miss.; at Havana, Cuba; and at San Francisco, California. All but one of these having been communicated to this Journal directly from their authors.

1. *Observations made at Lewiston, Maine*, lat. 44° 5′ N., long. 70° 15′ W.; by Prof. ELIAS LOOMIS.

Sunday, the 28th of August, I passed at Lewiston, in the state of Maine. The day was throughout unusually cold and very windy. In the evening, the wind was less violent, but still fresh from the northwest, and so continued until midnight. At 10 P. M. the thermometer stood at 53° F. and the next morning at 5 o'clock it stood at 50° F.

At 8^h 20^m in the evening I first noticed some remarkable auroral indications. Long brushes of pale white light were shooting up from the west and also from the east, and were directed towards a point considerably south of the zenith; while in the northwest was a large mass of light tinged with a decided rosy hue.

At 8^h 35^m P. M. the light in the east and northeast had also assumed a rosy tint, while that in the northwest had acquired a deeper red color. At the same time a dark segment rested upon the southern horizon, its vertex having an altitude of about fifteen degrees above the horizon, and its convex edge was bordered throughout by a vivid light which was nearly white but with a decided tinge of emerald-green. In the north was also seen a dark bank similar to that in the south, but less sharply defined, and rising to an altitude of about 30°.

At 8^h 45^m P. M. in nearly every part of the heavens the light had become more intense, and the streamers were continually varying both in position and in the intensity of their light, presenting the appearance of undulations. From nearly every quarter of the heavens the streamers converged towards one point, but terminated about ten degrees before reaching that point. That point was nearly equidistant from the three stars *Lyra*, *Altair*, and α *Cygni*, but somewhat nearer to Lyra.

At 8^h 55^m P. M. the elevation of the bank resting on the southern horizon did not exceed five degrees.

At 9 P. M. the light had broken through nearly the entire dark bank in the north, so that there remained only a portion of this bank of very irregular shape, and its average height did not exceed ten degrees. The point of convergence of the streamers was now about equidistant from the three bright stars above named, but inclining a little to the north of that central point.

At 9^h 5^m the illumination of the southern half of the heavens was much greater than that of the northern; but at 9^h 10^m the illumination of the southern half had sensibly declined and the

dark bank resting on the southern horizon had risen to a height of 15° or 18°.

At 9^h 18^m the point of convergence of the streamers was nearly equidistant from the stars above named, but somewhat nearer to *α Cygni.*

At 9^h 23^m the dark segment in the south was quite regular, and not more than ten degrees in height, and the bright border was very strongly illumined; while the dark segment in the north had almost entirely disappeared, and there was but little light in the northern portion of the heavens, nearer the north horizon than about forty degrees.

At 9^h 33^m a narrow beam of white light shot up from the west and another similar beam shot up from the east, which met at the magnetic zenith, forming a pretty well defined bow, and being nearly half of a great circle of the sphere. Throughout the entire portion of the heavens north of this arc, there was scarcely any trace of auroral light; while in the south the dark segment was complete, and the diffuse illumination above it was very strong; that is, the usual conditions of the aurora were entirely reversed, and it now appeared wholly on the south side of the zenith, with its base resting on the south horizon.

At 9^h 49^m P. M. the aurora was entirely confined to a region not rising more than 40° above the southern horizon, and it seemed as if the light was entirely disappearing, passing away towards the south, when very suddenly it increased in brightness, and rose higher in the heavens. Soon it became so bright that I could read with perfect ease the finest printed type. I took from my pocket a paper printed in *nonpareil,* (the finest type often used by printers,) and could read it by the light of the aurora with the same facility as at noonday. The streamers now converged to a point nearly midway between *α Delphini* and *α Cygni.* Soon they covered the entire heavens, reaching down almost to the north horizon. The light in many places, particularly in the south, at an elevation of about 45°, became of a brilliant crimson, and then commenced a succession of flashes like waves of light rolling up towards the magnetic zenith.

At 10 P. M. the point of convergence of the streamers was about equidistant from *α Delphini* and *α Cygni* and about three degrees east of the line joining those two stars. The flashes still continued, but the illumination was less intense.

At 10^h 10^m P. M. the light had become very pale and diffuse, particularly in the north.

At 10^h 14^m P. M. almost the entire heavens appeared of that dull slate color which usually characterizes the dark segment near the horizon; but at 10^h 19^m the whole heavens brightened up again with diffuse brushes of straw-colored light, all inclining towards the magnetic zenith.

At $10^h\ 24^m$ P. M. the point of convergence of the streamers was about equidistant from *α Delphini*, *α Cygni* and *Eta Pegasi*.

At $10^h\ 30^m$ P. M. the corona was very perfect, but the light was chiefly of a straw color, and much paler than it had been about ten o'clock.

At $10^h\ 45^m$ P. M. irregular streamers of pale light covered the entire heavens with the exception of a segment rising about thirty degrees above the southern horizon.

Soon after 11 o'clock I retired, but slept little during the night. The light of the aurora continued until day-light, and made my room nearly as light as a full moon would have done; and I frequently rose to observe the phenomenon from my window, which had a free northern exposure.

At 12 o'clock (midnight) the whole northern half of the heavens was covered with streamers of a diffuse yellow light, and whose borders were not sharply defined.

Aug. 29th at 2 A. M. the whole sky was covered with a haziness, while a number of light clouds of considerable extent were visible, and the whole was lighted up as by a full moon shining through them.

At 5 A. M. the sky seemed unusually clear with the exception of a few light clouds, mostly cirro-stratus, scattered irregularly over the heavens; but near the north horizon was a collection of cirro-stratus clouds forming together a bank rising to an elevation of about eight degrees, and similar to the dark segment observed last evening.

I subsequently ascertained that on the evening of Aug. 28th, snow and sleet were falling upon the summit of Mount Washington (the highest of the White Mountains in New Hampshire), and this snow remained unmelted for several days.

2. *Observations at Toronto, Canada West*, lat. 43° 39′ 35″ N., long. 79° 21′ 30″ W.; by Prof. G. P. KINGSTON, Director of the Magnetic Observatory. (In a letter to the Editors).

Magnetic Observatory, Toronto, Canada, Sept. 24, 1859.

Dear Sirs:—According to the promise conveyed to you in my note of yesterday I send you some facts relating to the Aurora of 28th August and following days. These facts you will notice are not given in a form suitable for publication, but must be considered only as materials for you to work up in the manner best adapted for your purpose.*

*** Prof. Kingston's letter was accompanied by a copy of his magnetic records for the two days named—Sept. 2d and 3rd—taken every *fifteen* or every *five* minutes, and for a part of the time every *two* minutes during the hours of observation. These records are extremely interesting and will undoubtedly be presented in full in the records of the Observatory. We have condensed from them the brief table here given.—EDS.**

In the magnetical observations the readings of the instruments have been compared with the normal standard readings proper to the time of observation, and the excess or defect from the standard have been then expressed in arc for the declination and dip and in parts of the horizontal and vertical forces respectively for those components of the force. The times of observation are expressed in hours and minutes Göttingen astronomical time. By these means the tabulated numbers are independent of instrumental peculiarities and of local time, and are therefore comparable with results similarly obtained from other quarters. That the deviations given are extraordinarily great will be apparent when it is considered that according to the rule adopted by General Sabine a disturbance is reckoned *large* when the declination differs 5′ the dip 1′ the horizontal force ·0012 and the vertical force ·00026 from their several normal values. Prior to the morning of Sept. 2, the instruments occasionally gave evidence of a disturbed condition of the magnetic elements but not to such an extent as to lead to any systematic reading of them excepting at the regular hours of observation. The Aurora first appeared about 7 : 40 P. M. of Sunday Aug. 28. From which time through the *whole night* the *whole sky* was covered with a brilliant mass of streamers, patches and luminous bands, which rose from all points of the horizon, the predominant color being yellow intermixed with patches of crimson.

At 8^h 10^m along the *south* horizon was seen a low bank of dark haze similar to that which is common on like occasions in the north horizon, and from which streamers occasionally issued extending towards the zenith and forming with streamers that converged from other points a corona about 16° south of the zenith.

At 8^h 25^m dense masses of red streamers extended in a band from N.W. to S.S.E., with an intermixture of crimson patches.

On the whole the aurora of Aug. 28 seems to have been characterized not so much by the activity of the phenomena as by the *extent* of the sky which it occupied, (the whole hemisphere,) and by the permanence; for there was little variation in the kind or intensity of the phenomena through the night.

On Aug. 29—Faint auroral light from 8 : 30 in the night, being clear and favorable for observation.

Aug. 30—Sky overcast.

Aug. 31—Clear and unclouded but no aurora recorded.

Sept. 1—Overcast till near midnight. When the sky cleared auroral light was seen accompanied by streamers. At 12^h 30^m a fine corona was formed round a point 28° S. of the zenith.

Sept. 2—Generally overcast with auroral light occasionally visible through the clouds.

Sept. 3—Aurora visible from sunset consisting of streamers with the formation occasionally of imperfect corona.

Sept. 4—Auroral light with occasional streamers.

Sept. 5—Unclouded, faint auroral light.

Magnetic Disturbance at Toronto, 2nd and 3rd Sept., 1859. *Table giving the variation of the Declination, Inclination, Horizontal and Vertical Forces, from the respective normal values.*

The variations of the declination and inclination are expressed in minutes of arc, and those of the horizontal and vertical forces in parts of the horizontal and vertical forces respectively.

— denotes a westerly deviation or increase of westerly declination and a decrease of dip and of force.

Göttingen time.	Declination.	Inclination.	Horizontal Force.	Vertical Force.	Göttingen time.	Declination.	Inclination.	Horizontal Force.	Vertical Forces.
D. H. M.	° ′	° ′			D. H. M.	° ′	° ′		
2·0·00	9·5	7·7	—·0191	·0028	8·00	14·1	— 2·8	·0024	·0039
·15	41·0	11·1	—·0129	·0039	9·00	11·3	— 2·0	·0016	·0040
·30	52·2	17·4	—·0233	·0033	·30	4·2	— 4·0	·0045	·0047
·34	12·6	16·9	—·0171	·0019	2 10·20	33·3	— 14·4	·0130	·0060
·42	— 40·3	25·0	—·0256	·0012	11·00	11·3	— 9·6	·0095	·0047
·48	16·6	26·1	—·0275	·0019	·10	— 9·7	— 10·8	·0113	·0050
·52	— 40·3	8·6	off scale	—·0027	13·00	6·6	— 1·6	·0044	·0045
1·00	33·1	1 7·3	—·0611	·0001	13 30	43·3	— 18·8	·0268	·0089
·04	— 16·6	46·9	—·0393	·0027	14·00	8·3	3·2	—·0027	·0044
·06	28·7	1 4·9	—·0601	·0036	15·05	— 31·3	13·2	—·0179	·0006
·08	67·6	24·6	—·0672	·0036	·45	22·7	40·0	—·0064	·0021
·10	— 13·7	1 19·6	—·0647	·0027	16·00	— 16·6	16·8	—·0174	·0031
·12	2 6·7	1 20·5	off scale	—·0022	·15	1 4·9	24·8	—·0120	·0006
·20	— 2·9	1 37·3	—·0765	·0025	17·00	— 6·3	3·6	—·0061	—·0014
·26	1 35·0	1 14·5	—·0717	·0056	·45	— 24·0	13·2	—·0015	—·0007
·36	1 41·2	1 42·5	—·0741	—·0013	18·00	— 10·4	9·2	—·0096	·0002
·40	54·4	1 16 9	off scale	—·0003	3 4·00	8·9	5·8	—·0056	·0021
·48	2 6·4	1 0·5	"	—·0031	·10	1·2	4·6	—·0044	·0016
·50	11·2	Off scale	—·0809	Off sc'le	·50	51·1	14·3	—·0146	·0026
·56	27·7	2 29·8	—·0857	—·0657	5·25	18·0	15·6	—·0127	·0034
·04	1 24·2	45·7	—·0566	·0000	·30	40·3	17·2	—·0167	·0033
·06	51·8	51·7	—·0549	—·0006	·40	2·2	18·0	—·0168	·0037
·16	—1 37·2	Off scale	—·0583	—·0021	6·00	— 11·9	15·2	—·0104	·0041
·34	1 26.0	1 16·9	—·0748	—·0005	·15	— 16·3	13·6	—·0081	·0040
·36	49·3	1 25·7	—·0724	—·0032	7·00	— 5·8	2·4	0000	·0043
·46	2 7·8	1 39·3	—·0680	—·0021	8·00	— 5·1	0·4	·0022	·0035
·58	57·8	47·7	—·0501	·0006	9·00	— 4·2	7·2	—·0032	·0028
·08	— 29·3	49·3	—·0472	—·0009	10·00	— 14·5	8·4	—·0063	·0028
·24	1 7·2	32·8	—·0406	·0003	3 11·00	1·5	8·0	·0067	·0021
·36	— 10·6	36 8	—·0360	·0000	12·00	6·1	— 0·8	·0028	·0037
·40	— 0·4	29·2	—·0275	·0013	13·00	31·0	— 18·8	·0185	·0037
4·00	32·8	22·8	—·0232	·0038	14·00	5·4	— 0·4	·0006	·0024
·16	8·6	22·0	—·0204	·0031	·05	1·1	1·6	·0011	·0023
·24	22·3	21·6	—·0147	·0035	·35	17·1	— 0·4	—·0014	·0012
·32	2·5	17·6	—·0154	·0041	·50	— 1·8	4·0	—·0025	·0012
·42	23·8	8·4	—·0123	·0039	15·10	— 4·0	4·4	—·0022	·0025
·52	— 1·4	12·4	—·0109	.0037	·35	29·0	4·4	—·0083	—·0012
5·02	14·8	15·2	—·0147	·0038	·45	— 32·8	7·6	—·0090	—·0012
5·18	— 4·3	10·4	—·0080	·0038	·55	— 16·2	9·6	—·9122	—·0012
5·45	15·1	5·2	—·0069	·0034	16·15	— 5·9	8·0	—·0080	—·0013
6·35	1·7	3·2	—·0043	·0027	·30	— 19·6	7·2	—·0059	—·0012
7·10	9·0	1·2	—·0024	·0040	3 17·00	— 13·2	6·8	—·0064	·0060

3. *Observations at New Haven* (lat. 41° 18′ 27″), by Prof. C. S. Lyman of Yale College.

The Auroral display of Aug. 28th attracted attention at New Haven before the disappearance of daylight; and at $7^h\,40^m$ mean time, when first seen by the writer, the whole northern quarter of the heavens was covered with a diffused, hazy light, rapidly changing its appearance, often of a crimson or yellowish hue, with occasional streamers, and with a denser mass of light, as usual, above the northern horizon. At $7^h\,45^m$ this light reached the zenith; at $7^h\,55^m$ it had passed 25° or 30° further south, and the marginal portion formed for a few minutes, an irregular belt or zone made up of evanescent fragments of arches, intermingled with streaks and patches of auroral light. No distinct bow, however, was at any time formed. At $8^h\,15^m$ this portion had nearly vanished, and the southern edge was only 3 or 4 degrees below *alpha Lyræ*, then near the meridian. Eight minutes later the edge touched *alpha Aquilæ* and in three minutes more was about 10° south of it. This southern margin was at times quite definite, and as it moved gradually towards the south the following notes were made of it at the time—the altitudes (near the meridian) being measured with a pocket quadrant, and probably in error less than half a degree.

At 8^h	27^m		alt. of edge	28°		
8	29		" "	20°	30′,	bright and regularly arched.
8	30	30^s	" "	17	15,	bright.
8	31	20	" "	15	45,	bright, broad, edge well defined.
8	33	15	" "	14	0,	at star Epsilon Sagittarii.
8	34	30	" "	14	0,	bright, and well defined.
8	35	30	" "	12	30,	bright, and very well defined.
8	37	40	" "	11	20,	edge, well defined.
8	38	30	" "	10	40,	nearly the minimum alt.
8	40	15	" "	12	45,	receding, 30′ or 40′ below star ε Sag.
8	42	0	" "	10	30,	second arch, first 4° or 5° above.
8	47	0	" "	12	30,	bright, edge well defined—at star ε.
8	49	30	" "	12	30,	edge at same star.

At this time a small bright horizontal cloud of light some 2° wide and 5° or 6° in length, and pointed at each end, formed rapidly, near the meridian, in the open sky just below the arch at an altitude of 9° 50′, and moved slowly to the west parallel to the arch, through a distance of 15° or 20° till it was lost to view behind trees, about a minute, by estimate, after its formation. This cloud appears to have been identical with one seen by Prof. A. C. Twining at West Point.

The star *epsilon Sagittarii*, referred to above, is found by computation to have had an altitude at $8^h\,33^m$ of 13° 36′, being then 45^m past the meridian. Its altitude at $8^h\,50^m$ was 12° 58′. When on the meridian at $7^h\,48^m$ it was 14° 18′.

At 8^h 52^m, arch at the south growing fainter and breaking up. In a few minutes that quarter of the sky was nearly free from light.

At 8:54 an imperfect corona formed at an altitude of 69°. At 8:56 a better one with bright wisp at its center, alt. 72°. At 8:58½, corona 72½° apparently in vertical plane cutting *alpha Aquilæ*. (Azimuth of the star then, by calculation, 8° 22′ E.) The corona at these times not very definitely formed.

At 9^h 5^m, a bright mass of light noticed in the east, irregular, expanding, and stretching obliquely upwards and towards the south. At 9^h 10^m this was met by a similar irregular mass of light stretching around simultaneously from the west, forming an imperfect band or arch, with very little light below it, its lower edge at this time having an altitude of 27° on the meridian. At 9^h 12^m its altitude was 20° 30′, at 9^h 23^m, 16° 15′, and at 9^h 31^m, 16°, soon after which it faded. While this second curtain was shutting down in the south, it was noticed that the light in the north was rising gradually. At 9^h 26^m 30^s its lower edge passed Polaris, and three minutes later was at an altitude of 62°, leaving the sky below nearly free from auroral light. At the same time, the phenomena overhead began to be more active and brilliant, streamers and cloudy masses of light of various hues, chiefly crimson, forming and vanishing about the corona, attaining a maximum of splendor from 36 to 43 minutes after 9, and at 49^m having become comparatively faint. This magnificent *umbrella-like* canopy, first formed by these tinted streamers and flashes about 9^h 33^m, and then extending not more than 30° or 40° from the corona, with an irregularly scallopped or fringed margin, rapidly expanded in all directions, being more brilliant towards the north, and there presenting the appearance of a descending curtain, or rather succession of curtains, until at 9^h 38^m, it had shut down to the horizon all round, except in the south. The magnificence of the display at this time was not surpassed by anything in the brilliant Auroras of 1837, as remembered by the writer. The curtains just mentioned had at one time something of the drapery-like appearance characterizing the Auroras seen by the French commission at Bossekop in 1838–9.

Although the position of the corona is known to coincide in general with the direction of the dipping needle, its altitude was several times noted with a view to ascertaining its fluctuations, if any. The coronal point, however, was seldom or never sufficiently definite to make the observations of much value for this purpose. In addition to the notes of the coronas before 9 o'clock given above, the following were also made at the time.

At 9^h 15^m 30^s altitude of C. 73°, very definite.
9 18 bright streak or cloud above C. (alt. 76°) lasted $1\frac{1}{2}^m$.

At 9^h	22^m		alt. 73°, fine corona, long streamers.
9	24	30^s	" 68° 30′, bright wisp near corona. C. not definite.
9	26	30	" 72 15, good corona.
9	28		" 73 15, " "
9	30	40	" 73 0, coronal cloud with rays from it.
9	33		" 73 40, definite, dark center of grand corona.
9	34	30	" 74 30, very fine and definite.
9	36	30	" 75 15, C. not definite, colored streamers, splendid canopy.
9	38		" 72 45, tints brilliant.
9	40		" 74 0, C. definite, bright red, whole display magnificent.
9	41	30	" 74 0, splendid.
9	49		" 73 45, display much less brilliant.
9	52 to 58,		brilliant flashes and pulsations, chiefly towards corona.
9	53	10,	a shooting star appeared about 15° above Polaris, moving rapidly towards the west over an arc of 15° or 20°.
9	58		Auroral light diffused, faint—colored flashes.
10	0		very little except in north.

Flashes and pulsations continued with varying brilliancy until after 11 o'clock, and according to the testimony of others, the display continued through the night, at times with much splendor.

The mean of the above altitudes of the corona is about 73° 20′. The dip at New Haven is about 73° 50′.

A similar display of rosy streamers and waving light, though less brilliant, was witnessed on the morning of Sept. 2, after midnight, as noticed in one of the morning papers. It was observed about daybreak by Prof. Forrest Shepherd, whose attention was particularly attracted by the rapid flashes and pulsations overhead, which seemed to him to indicate a very low elevation of the phenomena above the earth.

The display was continued on the evening of the same day, being most brilliant between 9 and 10 o'clock when the whole northern heavens to the zenith, and often beyond, was filled with upward flashes and pulsations here and there, chiefly of whitish light, and with but few streamers.

On Sunday evening Sept. 4th, there were indications of a bright Aurora, though a clouded sky prevented it from being particularly observed.

Auroral indications were also noticed on some other evenings of the preceding week.

Unfortunately no magnetic observations were made at New Haven.

The time piece used in noting the phenomena of the 28th was compared the same evening with the astronomical clock of the writer's observatory, and found to be only 5 seconds fast of N. H. mean time.

4. *Observations of Prof.* ALEXANDER C. TWINING *on the Aurora of Aug.* 28*th*, 1859, *made at West Point, New York.*

While the evening twilight was yet so strong as to make the phenomenon scarcely discernible, a rosy hue was seen spreading over a space reaching from the northeastern horizon to the north star and thence to my zenith, of uniform breadth throughout, and bounded south by a line through Alpha Lyrae, passing vertically down to the east. The time was 7^h 25^m by the watch—which however varied six minutes from true local time (too fast it is believed, making the local time 7^h 19^m). In about ten minutes the southern boundary moved to Alpha Aquilae, and the rosy light had extended itself visibly over to the west, and streamers were seen in the northeast. Very soon the northern sky became variegated nearly up to the zenith with advancing bands and flakes of yellowish and reddish cloud with streamers intermixed. At a quarter before eight o'clock, by estimation of the true local time, the streamers in the north were numerous; and by careful observation they were perceived universally to move towards the west.

At 8^h 35^m (by the watch) I looked again. A corona was then formed, and the auroral clouds and streamers were colored with tints of red and yellowish white. The most remarkable phenomenon was exhibited at the southern margin of the illumination. A yellowish cloud of extraordinary density and low altitude was seen advancing southward with an even and massive boundary which stretched entirely across the sky, in striking contrast with the clear blue beneath. It advanced beyond the bright star Antares, but soon receded and took a position which it retained ten or twelve minutes in a nearly level line exactly through that star, and a degree and a half, by estimation, below the star Epsilon Sagittarii. Its altitude therefore during that period—say from 8^h 40^m to 8^h 50^m (local time)—was about $11\frac{1}{4}°$, at the first named star, and about $11\frac{3}{4}°$ at the last:—at the meridian it was, probably, $12°$. This southern line gave an opportunity for comparative observations in different latitudes, which, if improved, will determine the height of that auroral cloud with an unparalled certainty and accuracy. There was also during this period another phenomenon equally remarkable and, if extensively observed in widely different latitudes, equally valuable. Ten or fifteen minutes before nine o'clock a bright spot formed at or near the meridian, and three or four degrees below the above named level margin. It soon became a long and narrow cloud—say $8°$ long and $2\frac{1}{2}°$ broad at the middle—but pointed at its eastern and western extremities. It moved to the west in the clear sky, and parallel to the cloudy margin above it. In its course it passed centrally over the pair of

bright contiguous stars in the end of the Scorpion's tail,—showing an altitude, at the cloud's middle line, of 7°. In two minutes—as I estimated from subsequent recollection—it moved about forty degrees. It then was hidden by the mountains in the vicinity. Soon after this disappearance it was observed that the entire expanse of cloud in the south from the zenith down was making a similar progress west,—at about the same rate, as nearly as could be estimated. At $8^h\ 52^m$ (local time) the original mass of vapor had moved nearly out of the southern field—leaving a far less dense and bright accumulation of cloudy strata over all that quarter.

At twenty minutes to a quarter before ten o'clock I observed again. The corona was then finely formed by streamers thickly and completely developed on every side. In about three minutes the display became suddenly very gorgeous, the red and white (yellowish-white) streamers and banks being very brilliant. So they continued for a quarter of an hour at least. In this period pulsations or auroral waves were seen propagating themselves rapidly upwards, and quite to the corona. That these did move upwards was determined by a close scrutiny. The *dome* was completed on every side. The southern streamers were particularly observed to originate beneath in a line or arch which I roughly, and without express verification, judged to be at about the altitude of the cloudy margin as observed at a little before nine o'clock. It may have been somewhat higher. At ten o'clock, or a little earlier, the phenomenon of the narrow cloud moving westward was strikingly repeated. The cloud however in this instance was longer and less definite in shape.

From ten o'clock to $12^h\ 15^m$ I did not observe. At this last mentioned time the auroral twilight shone brilliantly in the north, but my view in that quarter was obstructed.

I observed again from $2^h\ 45^m$ to 3^h. The corona and dome were more regularly and completely formed than previously at ten o'clock, and more than I have seen them in either of the grand auroras of the last thirty years. The streamers were narrow, thick set, evenly distributed, and traceable to the corona. High in the north, observed against the constellation Cassiopeia, they moved across it from west to east, contrariwise to the motion in every instance I have before observed in any aurora. Yet my morning observations on this particular (and nearly or quite universal and yet generally unnoticed) phenomenon of transverse motion have not been so numerous as at evening.* At the spot

* My conjecture as to the occasion of this remarkable feature of auroral phenomena has heretofore been the following:—a *streamer* may be taken as the visible path of some portion of an electric current, normal, or nearly so, to the great thermal current of the earth. Such a normal current, in conformity with known laws, will experience a lateral movement under influence of the thermal current. It will also act upon the latter,—thus affecting magnetic intensity at the earth's surface, and,

observed the motion was estimated as being fully 20° per minute. The ever varying wisps of cloud at the corona, and the southern streamers were also moving to the east. I left the display in full action without observing farther.

The repetition which took place Sept. 3d, although on a vastly diminished scale of grandeur, I observed about one hour,—say from 9^h to 10^h P. M. It was remarkable for the character of the auroral waves, which passed upward, illuminating successively different definite spaces in their path. The motion of these waves was far more moderate than I have ever before remarked. In this instance I could not estimate it to exceed forty-five degrees of arc in a second of time. The movement was everywhere distinctly upward; but the determination of arcual or angular motion in this phenomenon, is excessively difficult and inexact.

5. *Two letters from Prof. Daniel Kirkwood, Bloomington, Ind.*

[*First letter.*]

Aug. 29th, 1859.

TO THE EDITORS, &c.

Gentlemen:—The most extraordinary display of the Aurora Borealis I have ever witnessed was seen from this place last night. It was observed immediately after the close of twilight, and, in the course of an hour, the whole northern horizon from east to west was illuminated. *The phenomenon continued from twilight to twilight;* the brilliancy being greater at 4 o'clock this morning than at any previous hour. It was the lightest moonless night our citizens have ever known. Tints of various colors were seen in different parts of the heavens; but what struck spectators generally with wonder was a thin, gauzy cloud of brilliant red, which appeared first in the east about 9 o'clock in the evening, and which seemed to move almost horizontally till it reached the northwest; at 9^h 30^m lying precisely over the stars *Alioth*, *Mizar* and *Benetnash*, where it took the form of streamers, converging towards a point somewhat south of the zenith. At the same time an arch of light appeared, having one extremity in the horizon beneath, or rather westward of,

almost of necessity the declination and dip; which seem to be merely resultants of all the electro-dynamic actions upon the needle, subsisting at the time. Under the above hypothesis, therefore, every development of streamers must ordinarily concur with three other phenomena, viz., a lateral movement of the streamers, a change of the needle's direction, and a change of magnetic intensity. The hypothesis of a magnetic property in the auroral medium—whatever the latter be—seems wholly gratuitous. It is only requisite that the medium, or substance through or along which the current passes, shall be susceptible of illumination by such passage. Certain phenomena however indicate that the current transports the auroral vapor laterally with itself. The importance of this class of observations to questions relating to the cause of the aurora, as well as to the direction of currents, is obvious.

these red streamers, the other in the southeast; the zenith distance of its summit being about 40°, and its outer edge just reaching *Arcturus*.

Subsequently a splendid corona was formed, towards which the streamers moved in beautiful undulations. The most remarkable feature in the phenomenon, however, was its *extent;* not only the entire northern part of the visible hemisphere was illuminated, but the greater portion also of the southern.

I have just learned that during the night some lines of the magnetic telegraph were so much disturbed as to stop communication between different points.

[*Second letter.*]

Bloomington, Indiana, Sept. 9th, 1859.

TO THE EDITORS, &c.

Gentlemen:—Since the date of my hasty note of the 29th ult., we have had several more displays of the Aurora. Not having witnessed them myself, however, I have collected from others the following facts in regard to them: the first—a magnificent one—was seen by many of our citizens on the night of September 1st. It was noticed in the north about 11 o'clock, and gradually increased in brilliancy and extent until *the whole visible heavens were illuminated;* the light at times being such that ordinary print could be read without much difficulty. At 1 o'clock in the morning the portion of the heavens in which the light was most intense was almost exactly southeast, about midway between the zenith and horizon. The Stark County (Ill.) News thus describes the phenomenon:—

"On yesterday morning, (Sept. 1st) between one and two o'clock, the whole heavens were aglow with deep red light, which presented every variety of beautiful aspect imaginable. When we first looked out, it looked as if two brilliant suns had just set, one in the east and one in the west, and the sky, at either point was painted in broad streams of crimson and gold. This lasted but a moment, then a deep glow overspread the whole sky, brighter at some points than others, but all red. The light was so strong at times, that we could see to read fine print with ease, and gave to buildings and other objects, a dim glow, like fire-light. An arc of some 20° was formed over the southern horizon, the inside of which presented a silvery appearance like the edge of a cloud brightened by the moon, and from this, broad streams of a lilac color would flash up toward the zenith and abruptly end."

The displays on the nights of the 1st and 2nd, are described by the Indianapolis Journal of the 3rd inst., as follows:—

"*Another Aurora.*—Yesterday morning (Sept. 1) from midnight till day another Aurora, more brilliant than the first, in this locality at least,

was witnessed by those who had the good luck to be up at that time. At half past 11 o'clock it was quite brilliant, as a low arch of pure white light in the north, with but few radiations of colored light, and none that rose very high. It was very luminous, we could see as plainly as by moonlight, when the moon is quarter full, though the light was a paler and more ghastly kind, more like faded daylight than moonlight. Later in the night it grew much brighter still, and extended over the whole visible heavens. A beautiful column of red rays rose in the northeast, and another rose in the northwest, and met in the zenith, and from this point of junction a flood of red light poured out over the sky running down to the horizon on all sides, south as well as north, and the whole earth colored under its beautiful but ghastly crimson. Many who saw it say it was far more brilliant than the one of Sunday night, and it certainly was much more luminous, though less marked by the darting rays and wonderful pulsations that made the first so splendid. It was seen at Cincinnati, and all over the Union, we suppose, as the first one was. Such frequency and splendor of Auroras at this season we never saw or heard of before.

"*Still another.*—Another very beautiful Aurora Borealis was seen last night (Sept. 2) about half past eight o'clock. At that time it was confined to the north entirely. The rays shot up in very distinct cones or peaks of light, and beautifully variegated in color.

On Monday the 5th, about 2 o'clock in the morning, the phenomenon was witnessed for the fourth time within a week. Several beautiful streamers shot up from the northwest towards the zenith. The light, however, was of short duration.

It may be proper to remark that last evening, the 8th, about 9 o'clock, notwithstanding the bright moonlight, indications of the Aurora were again discoverable.

6. *On the Meteorological and Magnetic Phenomena accompanying the Aurora Borealis of Aug.* 28*th*, 1859, *as observed at Springhill (near Mobile), Alabama;* by Prof. A. Cornette, S. J.

I have thought that the meteoric conditions which preceded, accompanied and followed the Aurora Borealis of August 28th would be read with interest by all who witnessed that phenomenon on this memorable occasion. I copy from my daily journal without translating the French metrical numbers which I have for many years employed.

I add some hourly observations upon the perturbations of the magnetic current after the phenomenon, as well also as some observations on the subject at large.*

* In conformity with our design to give at present only facts, we reserve Father Cornette's ingenious speculations to another occasion.

Meteorological Observations at Springhill, lat. 30° 41′ N. ***Elevation*** **46 *metres*.** (In French metrical and thermometrical standards.)

1859	Barometer (uncorrected.)					Attached thermom.		Detached thermom.			Wet bulb thermom.			Absorption.			Temp. wells.
Aug.	4h	9h	12h	3h	9h	Min.	Max	6	2	9	6	2	9	Int'r mm.	Ext'r mm.	woods.	
27	760·0	760·9	760·7	759·6	760·0	27°	30°	22°·6	30°·3	24°·4	21·8	23·0	22·7	1·5	6·0	....	
28	59·1	60·7	60·4	59·0	59·0	28	30	22·7	30·7	26·0	21·8	25·0	23·8	1·5	6·0	3·0	21·1
29	59·2	59·9	59·8	57·8	58·5	27	28	24·2	26·4	24·3	22·0	23·0	23·0	1·0	4·0	2·5	
30	758·5	58·6	....	57·2	58·0	27	29	21·2	26·6	22·8	19·2	22·1	20·7	1·2	5·0	....	21·1

	WIND.			CLOUDS.			RAIN.			
	Morning.	**Evening.**	**Night**	**Morning.**	**Evening.**	**Night.**	**Morning**	**Evening.**	**Night.**	**mm.**
Aug. 27	**C N**	**N²**	**C**	**S**	**S**	**S**	**0**	**0**	**0**	**0·0**
28	**C** $\frac{\mathbf{N}}{\mathbf{S}}$	$\frac{\mathbf{N}}{\mathbf{S}}$	**C**	**S N :**	***n***	***n*–S N–**	**0**	**0**	**R^N 0**	**0·0**
29	**NW$_3$NW**	**NW**	**NW**	**N :**	**N–*n*,**	***n*;**	***p p***	**0**	**0**	**0·5**
30	**N**	**N**	**C**	***n*, *n* :**	***n*,**	**S.**	**0**	**0**	**0**	**0·0**

Explanation of the notation.

1st. ***For the winds.*—C calm. N² north wind of the 2d order, 5 being a gale.**
$\frac{\mathbf{N}}{\mathbf{S}}$ north over a south wind, or opposite winds as shown by clouds.
2d. ***For the face of the sky.*—S serene. N cloudy. *n*, slight cirrus clouds.**
***n* : nebulous clouds. N– slight stratus clouds.**
3d. ***For rain storms.*—*p* rain. R^N heat lightning to the north. T storm.**

Magnetic Declination (*relative diurnal*).

1859.	4h	6h	9h	12h	3h	6h	9h
Aug. 27	23′, 29″·5	......	34′, 56″·5	......	26′, 40″·5	23′, 29″·5	22′, 10″·0
28	34′, 56″·5	......	47′, 59″·0	......	29′, 50″·0	41′, 59″·0	66′, 54″·3
29	61′, 47″·5	47′, 6″·0	36′, 14″·0	40′, 0″·5	37′, 34″·0	30′, 50″·0	37′, 34″·0
30	36′, 15″·0	......	28′, 7″·0	......	25′, 59″·0	......	31′, 7″·0

In the night of August 28, *after the Aurora Borealis.*

Hours.	Decl'n.	Barom.	Therm.	Psych't	Hours.	Declin'n.	Barom.	Therm.	Psych't	Sky.
h. ′	′ ″					′ ″				
9 10	82 52·0	759·0	....	....	9 37	56 39·0	759·2	...	...	
15	76 29·0	....	25·8	23·8	50	64 21·0	....	...	...	
20	71 23·0	759·1	....	....	10 0	65 39·0	....	...	...	
25	58 39·5	....	....	....	10 10	61 47·5	759·4	25·0	24·1	S
29	50 17·5	....	....	....	4 A. M.	61 47·5	....	25·5	23·4	N–
9 34	55 25·0	....	....	....	5 A. M.	32 24·0	....	25·0	22·2	N :

In order to a full understanding of these tables it would be requisite to know also the whole course, absolute and relative, of the various atmospheric phenomena. This would be too long an undertaking, although the means are at command. But from the observations of the four days mentioned, we are able to draw the following conclusions:

1st. The density of the air shows an unusual course. The barometer daily rises, as we know, under the equator (and at Springhill), from four to nine o'clock in the morning, and from four until nine in the evening, and it falls regularly in the intermediate hours. During six years I have scarcely found a single

exception to this law between the equator and Mexico, and the exceptions are very rare at Springhill. Such an exception happened on the night of the Aurora Borealis (Aug. 28) when the barometer remained stationary from three to nine, and rose after nine when it should have fallen.

2d. The temperature fell considerably but not until the next day (29th) under a northwest wind, which had not blown for a long time, and which is ordinarily cold.

3d. The tension of watery vapor in the air was slightly modified. The mean degree of saturation on the 27th and 28th was 21°·35, tension $18{\cdot}7^{mm}$; 29th and 30th was 22°·40, tension 19·9. The 28th at 9 in the evening during the phenomena 22°·26, tension 19·7; 28th at 10 in the evening after the phenomena 23°·47, tension $21{\cdot}2^{mm}$.

4th. The absorption of water by the atmosphere either in an open vase, upon the belvidere of the college, in a room, or in the forest, was considerably more before than after the phenomena.

5th. On the 28th of August there were two diametrically opposite winds. The south, on the earth, and the north, in the upper regions, driving the cirrus clouds to the southward. The 29th the northwest wind prevailed, lowering the barometer.

Without doubt this opposition of winds is due to some extraordinary phenomenon, by which the atmospheric equilibrium was destroyed. I have been able both here and under another sky, to recognize that there is some intimate relation not only between the struggle of the winds and the course of the magnetic currents, but also (the discussion of which is out of place here) to reach an induction in explanation of earthquakes. That fearful phenomenon which I have felt and observed seventy-three times, has always occurred during a calm following a struggle of winds.

6th. Before the Aurora Borealis cirrus clouds (frequently caused by contrary winds) prevailed.

7th. The magnetic declination is the essential point which demands our attention: declination relative, hourly or daily. The normal daily course of the magnetic needle in the northern hemisphere is well known, viz., it moves to the east from four o'clock in the morning till near eleven, and from three till near ten in the evening, and returns to the west in the intermediate hours. In the southern hemisphere the course is opposite.

Near the equator the course is regular and the amplitude restricted. In high latitudes it is more disturbed and the amplitude larger. Three years observations in 4°, 14°, and 19° north latitude, leaving me no doubt upon the accuracy of these maxima and minima. In these latitudes this daily march was disturbed only during earthquakes, and returned to its normal order after the quaking. At Springhill (where I have followed

its daily course five times and even eight times a day according to my occupations, since June, 1858) it has had a regular course depending on the wind from the end of September (1858) until the 17th of August last. In short, from August and in September it has experienced great perturbations which I was tempted to attribute to the influence of the comet of last fall. But the Aurora of August has destroyed my conjectures and cast a new light upon this mystery. Since the 17th of last month (Aug.) the normal course of diurnal declination was scarcely recognizable and consequently I have followed it with the more interest. This disordered movement reached its maximum of observed perturbation at 9 o'clock 10 minutes in the evening of the 28th of August immediately after the auroral phenomena, and its course has since become as irregular as before. The perturbations were finished near 4 o'clock in the morning of the 29th, and last evening (September 1st) the declination had gradually diminished.

By the tables at the opening of this communication we see that the easterly declination between 3 in the evening and $9^{h}{\cdot}10$ in the night was $58' \, 2''{\cdot}0$. This is the first occasion I have been able to seize upon so considerable an anomaly in so short time. The needle subsequently made two new oscillations up to 10 o'clock 10 min., when I retired.

This morning at 4 the needle had attained another considerable maximum. I ran to the window in time to see the conclusion of another Aurora Borealis. The Aurora of the evening lasted, I understand, until near 3 o'clock, and with a light as brilliant as that of the moon, but without luminous rays, neither was there much diffused purple light. The same cause had produced the same effect, since that moment, (which does not coincide exactly with its maximum) the declination has decreased gradually. The Aurora to-day descended quite to the horizon; it appeared as a little cloud at the northeast and was dissipated at 4 o'clock 30 minutes A. M.

The purple light extended from the north on the night of the 28th of August at an angle of 80°, accompanied by thin sheafs of white light which shot up for a moment from the magnetic pole to the height of *Polaris* (30° 41′).

If observers in different latitudes could have established the conclusion that the opposed aerial movement reigned simultaneously in the atmosphere and developed in the air electric tension, that a calm followed the struggle, and that the Aurora Borealis happened during a calm, they would have made a glorious conquest for science.

But these facts remain yet to be observed. No Aurora Borealis appeared to me in the equinoctial regions as far as lat. 20° from 1847 to 1857. The first which I saw—at Troy, N. Y.,

July 25th, 1857—took place after a rain storm and above a low characteristic cloud during a calm which followed a contest between a south and southeast wind. It was less brilliant than that of August 28th.

The Aurora of August 28th took place in a calm after a struggle between two opposite winds, and that of to-day took place in the calm after a day in which the north wind prevailed in the morning and the south in the evening, but the clouds were immovable and induced the belief that the south wind was low, and that the north wind had ceased.

The Aurora Borealis of the 28th appears to authorize the inference that the light diverged from the magnetic pole, or that it was produced by a radiation of the polar magnetism from the terrestrial magnet. The most brilliant rays which escaped, emanated rapidly from a center below the horizon and that center was in the direction of the magnetic pole. A simple plumb line showed that the rays which reached *Polaris* were not perpendicular beneath that star but were inclined to the east some degrees.

Now the magnetic pole at Springhill is at 6° 28′ east, (mean from several observations). The other inclined rays might have served to determine the place of this center had time permitted my arranging an instrument for taking their sine.*

The low clouds frequently characteristic of the Aurora Borealis did not appear with those of last night. On the 28th there was an expanded and regular stratus in the horizon even to the height of about 8°, with heat lightning from time to time from the northwest.

7. *Observations at Jefferson Co., Miss.* (about lat. 31° 50′, lon. 91°), by an anonymous correspondent—published September 9th in the Port Gibson Reveille.

The Aurora Borealis of Sept. 1, 1859.—My attention was attracted at 11 o'clock last night, (Sept. 1st) to this rare but beautiful celestial phenomenon.

A belt of white light tinged with pink shot up from the northern horizon to the height of twenty or twenty-five degrees and extended east and west nearly the same elevation. Looking to those points I noticed the color deepening until about N.E. and N.W. it attained a bright deep scarlet red, like deeply tinged clouds of our dry-weather sunsets. It shot up in irregular columns arising in places almost to the zenith and spreading out fan shaped and paling as it rose. The white light was stationary except apparently sinking lower or rising higher. The colored

* It was equally impossible to prove that the rays change their direction at the same time that the magnetic needle changes its direction.

portions evolved, rolled, curled, and changed place and color, like the vapors climbing a mountain side. There was a very light surface breeze from the N.N.E. but the tendency of the meteor was to S.S.E. At half-past twelve, it embraced almost the entire northern hemisphere west, and at the height of from 45 to 60 degrees, a broad scarlet belt pointing S.W. to N.E. appeared, 30 degrees long and half as wide, having a dozen bright bars running longitudinally from end to end. It presented every color of the rainbow except blue. At the same time a brownish red column shot up from the N.E. resembling the flame of a huge lamp or candle, vibrating and flickering as though disturbed by wind. No sound was heard.

At 1 o'clock A. M., the white light under and to the left of the polar star was as bright as twilight half an hour before sunrise of a fair morning and extended almost to the zenith. I could see every object in the rooms—the hands of a clock and watch—out of doors the earth had a reddish glare, and every thing was as visible as at half moon, but more distinct as no shadows were cast.

In the white portions the stars were dim but in the colored parts east, west, and overhead were very bright but reddish, like the planet *Mars*. *Aldebaran*, the *Pleiades*, *Orion* and the two dog stars rose during the time and were unusually brilliant. The southern hemisphere looked dark and gloomy from contrast, but was without a cloud. All around the northern horizon there was a thin narrow belt, barely reaching the tree tops of cirro-stratus clouds. The lights were evidently beyond these. I counted seven meteors shooting athwart the heavens, from S.W. to N.E. during the two and a half hours I was up, similar to those of the great meteoric shower of November 13th, 1833, and such as may be seen any fair night between the 10th of August and 1st of December.

We witnessed an Aurora the early part of October 1851, large and brilliant for this latitude, but in no ways comparable to the one of last night. The succeeding winter was long and unusually cold.
SENEX, SR.

Jefferson Co., Miss., Sept. 2d, 1859.

8. *Description of two magnificent Auroræ Boreales observed at Havana, Cuba.* (In a letter from M. ANDREAS POEY, Director of the Physio-Meteorological Observatory at Havana, Sept. 8th, to the Editors.)

The appearance of the Aurora Borealis in the twenty-third degree of north latitude is an event so rare that it naturally produces fear in the common mind, and arrests the attention of men of science. The records and traditions of Cuba show but few examples of the occurrence of this phenomenon. The *first* is

said to have been seen on the 13th of November, 1784; the *second* upon the 14th of November, 1789; the *third* in 1833 (Nov.?); the *fourth* on the 17th of November, 1848; and finally the *fifth* and *sixth* now recorded.

First aurora on the night of Aug. 28th–29th, 1859.—The first appearance of a reddish gleam was seen at 5 minutes past 9 in the evening, which rapidly rose exactly in the north and extended over the space embraced between the N.E. and N.W., reaching the height of *Polaris* about 23°. Some persons, it is said, saw it as early as $8^h\ 45^m$. Its color grew brighter until $9^h\ 30^m$, but from this time it faded to its total disappearance at 10^h. A slightly luminous and whitish tint afterwards covered this part of the sky. But at 1 o'clock it reappeared, reaching again to *Polaris*. It attained its maximum brilliancy at 4^h to $4^h\ 10^m$—its base being of a beautiful carmine red, from which rose divergent rays of a variable diameter, some fire-colored, others whitish, and rising to the zenith, the reddish tint covering a space of 180° from N.E. to N.W. At $4^h\ 20^m$ the aurora disappeared entirely.

Second Aurora on the night of the 1st–2d *of September*.—This second Aurora having been incomparably more brilliant, more extended, and more permanent than the first, it seems best to notice the details of its development with care, as points of comparison with observations in higher latitudes. This aurora was not visible before $12^h\ 30^m$, and from that moment to 5^h A. M. I followed all its changes. From $12^h\ 30^m$ to $12^h\ 45^m$ it spread towards the east, and afterwards towards the west, then turning yet more towards the east with white rays which grew pale at the extreme west. From 12^h to 1^h after the white rays became extinct a portion of the east appeared of a beautiful fire-red. A part of the west became also more flaming, and the summit of the arch, poorly defined, attained the height of *Polaris*, with a movement of translation toward the east. At 1^h a brightness streamed from the north moving towards the N.N.E., defining by its light the outlines of cumulus clouds, of the horizon, of the sea, and the entrance of the fort. As this brilliancy increased and rose above the horizon its tints passed into light blue, involving the red portion at the northeast, and presently it began to fade out. The upper red segment rose considerably above *Polaris*. The illumination faded towards the northwest and embraced the whole of the auroral base; afterwards it rose again to the height of 12°. White rays with red and blue were then seen towards the west, which dilated longitudinally, oscillated laterally, were extinguished and resumed their brilliancy again by turns. The intensity of the illumination increased towards the east, and the red segment towards the west became more brilliant and more extended, until at the E.N.E. it

reached its maximum of brilliancy. At 1^h 15^m these rays were spread over the whole Aurora. The illumination attained to the E.N.E. in the space of three minutes, then it extended to the N.N.W. The east and still more the west then became very red. The illumination reappeared next at the east. The whole Aurora now became very red with rays to the north and west. This shade spread almost to the zenith. The fire-red of the west remained constant. The general depth of the Aurora faded while the whitish and reddish rays became more brilliant. But it was from 1^h 30^m to 3^h 15^m that the half hemisphere of the north from east to west was completely covered by a rich red tint, more orange than carmine, the gently arched summit of which passed the zenith towards the northeast, attaining the height of 100 degrees, accompanied with whitish rays and also with the red rays, more vivid then the general tones of the segment rising to the zenith, yet without passing it. At 2^h the Aurora had attained its highest magnificence. The heavens then appeared stained with blood and in a state of complete conflagration. At a vast distance above the upper red segment appeared a second whitish segment which rose 23° above the horizon, while the upper red segment spread for 100° to the northeast and towards the constellation of Orion. The illumination whose different phases I have followed then constituted a white arch, the central and visible base of the Aurora above a bed of cumulus clouds which reached 8° above the horizon. At 2^h 45^m the two segments or arches of the Aurora declining toward the horizon, the lower white one first disappeared at 3^h 15^m A. M. From 3^h 30^m to 4^h the general reddish tint disappeared and reappeared many times, but remained more intense towards the northeast. From 4^h to 5^h it gradually declined as the dawn commenced. At last the Aurora disappeared at 5^h A. M. in the prolongation of the magnetic meridian where it made its first appearance. From 1^h the west was constantly more flame-colored than the east.

These two Auroras have manifested the following peculiarities worthy of remark. 1st. The reappearance on the third night. 2d. Their magnificence: in height considerably more than 100°, in extent over 180°, their long continuance to day-dawn here under this latitude of 23°. 3d. The absence of an obscure lower segment although it might readily have been covered with the cumulous clouds which rose 8° above the horizon: above all, the expanse of the Aurora, a segment the extent of which has not been well established. 4th. The great height of 23° of the luminous segment or lower white arch visible only in the second Aurora. 5th. The rays or jets of light, some of which rose diverging from a point very far below the horizon, while others springing from the centre of the Aurora appeared to converge

slightly toward the zenith. Again they vanished for an instant to reappear over other points, some having a brilliant red, others a dense white mass with a feeble lateral pulsation and an alternate elongation and shortening. Sometimes the base of the rays was most brilliant and most deeply red colored, soon again the deepest and most brilliant color was on the upper extremities. 6th. The reiterated movement of translation of the whole aurora from east to west, followed by retrocession in an opposite direction, movements noted as being very rarely observed.

Space does not allow me to notice the concomitant phenomena which were produced, which from their importance will be the object of the next communication which I shall have the honor to address to the Academy. I enumerate the principal points observed. 1st. There was no noise in the aurora. 2d. The freely suspended needle of Marianini's Ré-Electrometer manifested not the slightest oscillation. 3d. The gold leaf electroscope of Bohnenberger gave no sign of atmospheric electricity. This neutrality of the magneto-electric force in thé presence of so magnificent an Aurora Borealis is worthy of remark, for these two pieces of apparatus constructed by M. Ruhmkorff have great sensibility. 4th. There was no trace of polarization in the auroral light but very sensibly in its reflection upon the surface of the sea and upon the opposite clouds. 5th. It was perfectly calm. 6th. The temperature and barometric pressure were as usual. 7th. Two days after the Aurora the barometer rose from a half millimeter to one millimeter, following the height of the diurnal tide, and a northeast breeze set up.

9. *Observation at San Francisco, California;* by Dr. JOHN B. TRASK. (In a letter to the Editors, dated Sept. 1st, 1859.)

On the night of the 28th of August, at the hour of 10 o'clock, and continuing from that hour until near daylight we had for the first time in ten years in California a fine display of the Aurora. The sky was illuminated from the northwest to the northeast, with a flood of crimson light extending to the zenith, through which the whiter and yellow columns would start at varied intervals. It was a magnificent display and will compare favorably with the best varieties of your wintry months.

10. *Height of the base of the Auroral curtain, Aug.* 28.

The minimum altitude above the southern horizon of the lower margin of the meridional part of the auroral curtain, seen during the display of Aug. 28th, previous to 9 P. M., was determined independently by Prof. C. S. Lyman and by Mr. E. C. Herrick at New Haven, and by Prof. A. C. Twining at West Point, N. Y. These three determinations were made at about

the same absolute time (about $8^h\,40^m$ New Haven time) and range from 10° 40′ to 12°. Fortunately, a like observation was made at Philadelphia, Pa., (N. lat. 39° 57′), by Mr. Chas. J. Allen, where and at Burlington, N. J. the display was observed by Mr. Allen and by Messrs. Benj. V. Marsh and Samuel J. Gummere. Mr. Allen found this minimum altitude at Philadelphia to be about 22½°. Assuming that the curtain was for a moderate distance parallel to the earth's surface, and that the observers saw the same curtain, it follows that the lower visible margin thereof was about forty miles above the earth. The probable error of this result seems to be quite small, yet it is highly desirable that the conclusion should be tested by observations taken at places between New Haven or West Point and Philadelphia and beyond, as far as Annapolis or Washington. The elevation of auroral belts observed in New England has been found to exceed one hundred miles, but the relation between auroral belts and streamers is little understood.

11. *Appeal to Observers.*

It is conceded that there is much connected with the auroral light which has not yet been fully explained, but it is unquestionably one of the most important of all meteorological phenomena, and its full explanation would probably bring with it the explanation of a large number of other phenomena, such as the origin and laws of atmospheric electricity, as well as of terrestrial magnetism. It is then of the highest importance to science that we should ascertain what the aurora is. The Aurora of Aug. 28th and following days affords a peculiarly favorable opportunity for deciding this question, and it is therefore important that this Aurora be thoroughly investigated. A thorough investigation of a single Aurora promises to do more for the promotion of science than an imperfect investigation of an indefinite number. It has been decided therefore to make a strenuous effort to investigate the laws of this auroral exhibition. For this purpose we need a careful collection of all the observed facts; and it is earnestly requested that every person who made accurate observations of the Aurora of Aug. 28th would communicate them to us for publication. This appeal is addressed to men of science in every part of North America where an Aurora was seen on the night of Aug. 28th. It is also addressed to observers on the ocean, and indeed throughout every portion of the globe, with the sole exception of Europe; for we assume that the appearances in Europe will be fully reported through the European journals. It is not improbable that this auroral exhibition may have been witnessed throughout the principal part of the northern hemisphere; and it is of great importance to know how far it did extend.

In order to render the communications of observers more definite and precise, we will briefly indicate the kind of information we desire.

We desire an accurate but concise description of all the phenomena with the *exact time* of their occurrence.

1. If a dark segment was seen resting either on the northern or southern horizon, or both of them, its altitude and position should be accurately stated.

2. If the streamers were seen to converge to a single point of the heavens, this point should be accurately located and the time of observation given.

3. If any single phenomenon (such as a detached luminous arch extending from the east to the west horizon) was so conspicuous as to be easily identified, it is important to have an accurate statement of its position and the altitude of its vertex, with the time of its formation and disappearance.

4. Was the Aurora seen in the southern half of the heavens, and how near the southern horizon did it extend?

5. Describe the color of the light, as well as its intensity.

6. If the Aurora exhibited any great variations of brilliancy it is important to know the times of least as well as the times of greatest brilliancy.

7. Did the Aurora exhibit any sudden flashes? Were there any pulsations like waves of light rushing up from the horizon?

8. If any observations were made showing the influence of the Aurora upon the magnetic needle, it is desirable that they should be communicated in detail.

9. The kind and degree of influence exerted upon telegraph wires.

10. Was any motion of translation observed in the Aurora, and if so, in what apparent direction and with what velocity?

It is proposed to publish in future numbers of this Journal, the most important part of whatever information may be obtained as the result of this appeal; and it is intended to present the facts in such a form that each one will have all the materials which are necessary to conduct the investigation for himself. After all the facts have been communicated, it is proposed to present an analysis of the whole, with some speculations on the general subject of Auroras. Observers may forward their communications either to the "Editors of the Journal of Science, New Haven, Ct.," or to "Prof. Elias Loomis, New York City," who has consented to undertake the discussion of the phenomena.

Postscript.—Any exact data, relating to the remarkable auroral arch of April 29, 1859—mentioned by Mr. Herrick on p. 154 of this volume, will *be very acceptable.*

ART. XLIII.—*Account of several Meteoric Stones which fell in Harrison Co., Indiana, March 28th*, 1859; by J. LAWRENCE SMITH, M.D., Prof. Chemistry, University of Louisville, Ky.

HAVING become acquainted with a remarkable phenomenon accompanied with a fall of stones that occurred in Harrison Co., Indiana, I immediately made enquiries concerning it, expecting to visit the neighborhood on an early occasion; but I was fortunate enough to learn of some admirable observations made by Mr. E. S. Crosier, and in fact so complete were his examinations that I clearly saw that no additional information could be elicited by my resorting to the spot. Mr. Crosier obtained for me the various stones that had been found, and also put himself to much trouble to obtain the information desired.

The stones fell on Monday the 28th of March, 1859, and Mr. Crosier visited the place on the Saturday following; in the mean time the following stones were discovered:

No. 1,	weighing	19 oz.,	discovered	by	Goldsmith.
2,	"	4¼ oz.,	"	"	Crawford.
3,	"	420 grains,	"	"	Lamb.
4,	"	167 "	"	"	Mrs. Kelly.

The following are the facts elicited by enquiry on the spot.

The time at which it occurred (4 o'clock in the afternoon) rendered the phenomenon of ready observation. The area of observation was about four miles square, and wherever persons were about in that area, the stones were heard hissing in the air, and then striking on the ground or among the trees.

Hardly a single person in the immediate vicinity of the occurrence saw any flash or blaze as was noticed by all who heard the report from a distance.

Three or four loud reports, like the bursting of bombshells, were the first intimations of anything unusual. A number of smaller reports followed, resembling the bursting of stones in a lime kiln. The stones were seen to fall after the first four loud explosions. Those who happened to be in the woods or near them heard the stones distinctly striking amongst the trees. In some places the noise of the falling stones in the woods alarmed the cattle and horses in the vicinity, so that they fled in terror. A peculiar hissing noise during the fall of the stones, was clearly heard for miles around. A very intelligent lady described it as very much like the sound produced by pouring water upon hot stones. The air seemed as if all at once it had become filled with thousands of serpents.

Mr. Crawford and his wife were standing in their yard at the time, and hearing a loud hissing sound overhead, on looking up

a stone (No. 2) was seen to fall just before them, burying itself four inches in the ground, they dug it up immediately, but it did not possess any warmth; it had a sulphurous smell. Another which they did not find fell near them, when they thought it prudent to retire to the house.

Two sons of John Lamb were in the barn yard attending to the horses, when their attention was called to a loud hissing noise above, and immedialely a stone (No. 3) fell just at their feet, penetrating the hard tramped earth some three or four inches, and they state that it was warm when taken from the ground. Another fell in a peach tree near by, but the ground being newly plowed they were unable to find it.

The largest stone (No. 1) was not obtained until the following day, being dug up beside a horse track on the streets of Beuna Vista, Indiana, it having penetrated the hard gravel to the depth of four or five inches. It had a strong smell of sulphur. The last (No. 4) was dug up by Mrs. Kelly the following day in her yard.

These four aërolites, owing to their being buried deeply in the ground, are all that have been found up to this time. None have been found or were heard to fall over a greater area than four miles square.

These are all the details that I have been able to gather connected with this fall of meteoric stones. They are highly interesting and probably as accurate as it is possible to obtain.

Nos. 1, 2 and 3 and a fragment of No. 4 were placed in my hands for examination. Nos. 1, 2 and 4 are cuboidal in shape, No. 3 was considerably elongated; they are all covered by a very black vitrified surface, equally intense on every one and on every part of each one, and when broken show the usual grey color of stony meteorites interspersed with bright metallic particles.

The mean specific gravity is 3·465; when broken up and examined under a glass four substances are distinguishable: metallic particles, dark glassy mineral, dark dull mineral, white mineral matter.

Examined as a whole the following elements were found in it: iron, nickel, cobalt, copper, phosphorus, sulphur, silicium, calcium, aluminum, magnesium, manganese, sodium, potassium, oxygen.

By the action of the magnet it was separated into

Nickeliferous iron,	4·91
Earthy minerals,	95·19
	100·00

The earthy minerals acted on by warm dilute hydrochloric acid, thrown on a filter and thoroughly washed, then treated

with dilute caustic potash, to dissolve any silica of the decomposed portion that was not dissolved by the acid, gave

Soluble portion,	62·49
Insoluble portion,	37·51

The metallic portion separated from the earthy part gave

Iron,	86·781
Nickel,	13·241
Cobalt,	0·342
Copper,	0·036
Phosphorus,	0·026
Sulphur,	0·022

The earthy portion freed from metal gave

Silica,	47·06
Oxyd iron,	26·05
Magnesia,	27·61
Alumina,	2·35
Lime,	0·81
Soda,	00·42
Potash,	00·68
Peroxyd manganese,	trace, not estimated.

It is clear from the analyses as made out, that these meteoric stones contain the constituents frequently found in similar bodies, namely: nickeliferous iron, phosphuret of iron and nickel, sulphuret of iron, olivine, pyroxene and albite; and in about the following proportions.

Nickeliferous iron,	4·989
Schreibersite,	·009
Magnetic pyrites,	·001
Olivine,	61·000
Pyroxene and albite,	34·000

I have no intention to enter into any speculations in relation to these meteoric stones, although I have accumulated some additional matter on the subject since my memoir on meteorites published in the Am. Jour. Science, vol xix, pp. 152 and 322, intending to reserve their publication for a future occasion.

Louisville, Ky., Oct. 1, 1859.

Art. XLIV.—*Geographical Notices.* No. IX.

The Inland Seas of Africa. Sources of the Nile.—The Royal Geographical Society of London have awarded the Founder's Medal for the current year to Capt. R. F. Burton, of the Bombay army, for the discovery of the great lake of Tanganyika, in Africa, the more northern lake being discovered by his coadjutor, Captain Speke. The journeys of these bold explorers have been previously mentioned in this Journal. On June 26, 1857, the two travellers left Zanzibar for the interior

and succeeded in reaching the great lake Tanganyika, 300 miles long, and 30 broad, which lies about 700 miles from the coast. Captain Speke proceeded from Unyanyembé to another vast inland lake called Nyanza, the south end of which was fixed by him at 2° 30′ S. lat., and 33° 30′ E. long. It is estimated to have a width of about 90 miles, and is said to extend northward for upwards of 300 miles.

Sir Roderick I. Murchison, President of the Royal Geographical Society of London, in his annual address gives the following account of the discoveries of Burton and Speke which are particularly important in reference to the long disputed problem of the Sources of the Nile.

"Returning to Europe from Aden, both Captains Burton and Speke sought and obtained employment in the Turkish contingent of the allied armies operating in the Crimea. Thrown out of their military career by the peace, they returned to the east coast of Africa, with the view of exploring the country from the coast of Zanzibar as far inland as might enable them to ascertain the real geography of the interior in that latitude.

"Aided by the late Colonel Hamerton, our meritorious consul at Zanzibar, and by Seyd Majid, the second son of the Imaum of Muscat, now the Prince of Zanzibar, the travellers made an experimental journey from that place on the coast to Fuga in the mountain country of Usambara. In their last and great expedition they again proceeded from Zanzibar. Their party consisted of twelve Belooches furnished by the kindness of the Sultan, some negroes who had been slaves, and asses for the transport of goods and for riding. Passing over the delta and low hilly country called M'rima, they entered the mountainous coast range at about 120 miles from the coast. This range which rises to a maximum altitude of 6,000 feet, with a width of about 90 miles, is chiefly composed of sandstone and crystalline rocks, the true character of which will be ascertained when Captain Burton's specimens arrive.

"Descending from the coast range to the great interior plateau land, at a lower level, and travelling over some poor lands, they reached a rich country in which knolls or bosses of granite and basalt rise up like rocks in an ocean. The country is exclusively peopled by negroes, none of whom are Mahomedans, as are the Somaulis and trading Arabs of the coast.

"Like the Negroes described by Livingstone, they have no special religion, trusting solely to good and evil spirits. Such of them as have sultans are on the whole peaceable, fire-arms being rare among them. Their country produces cotton, tobacco, maize, sweet potatoes, a great variety of pulses, manioc, yams, plantains, and melons; they manufacture iron, cotton fabrics, have abundance of cows and goats, and live in comparative comfort.

"From Kazé, in Unyanyembé, a spot where the Arab traders have established a sort of mart, and where articles from the coast are bartered for ivory and slaves, the travellers moved westerly until they reached the long inland mass of water trending from S. to N., which has been styled Uniamesi and Ujiji, but the real name of which is Tanganyika.

"This lake was found to be 1,800 feet only above the sea, or about half the average height of the plateau land west of the coast range. It has a length of about 300 and a breadth of from 30 to 40 miles.

"This great internal mass of water was determined to be an insulated depression into which streams flow on all sides. It was crossed by Speke in the centre, and navigated conjointly with Burton to near its northern end, where it is subtended by mountains which were estimated to have a height of from 6,000 to 7,000 feet within the range of the eye.* Its waters are perfectly *fresh* and peculiarly agreeable to drink, and it abounds in delicious fish, whilst its banks are grazed by red oxen of large size, some of them having stupendously long horns. Oxen are indeed common over nearly all the region examined, for the *tsetse fly*, the scourge of the more southern African countries, in which Livingstone travelled, is unknown.

"A singular phenomenon of blindness affected for some time both the travellers. Whilst exposed in the arid, hilly coast range, and also in the plateau land, to a fierce and glaring sun, their sight was unaffected; but on descending into the verdant, well watered, and rich lacustrine expanse of Tanganyika their sight was dimmed, and gradually they became almost blind—their recovery being slow and imperfect. It was this calamity alone which diminished the number of astronomical observations made by Captain Speke, who lost no opportunity of fixing the latitude and longitude of numerous positions.

"When returned to their chief central station in Unyanyembé, Speke, thriving upon hard field work, left his invalid companion

* Since this Address was delivered, the British Museum has acquired a curious, large, old Portugese MS. map of the world, on the Mercator's projection, made by Antonio Sances, in 1623, which shows how much general knowledge of the interior of Africa was possessed at that period by the Portugese. On this vellum map, the author distinctly places one large body of water in the centre of Africa, and in the parallel of Zanzibar. Although all the details are inaccurate, and he makes the Congo flow out of this lake to the west, and another river (representing probably the Zambesi), which is called R. de St. Yurzes, from the same to the S.E., still the general notion of great internal waters is there put forth.

Chevalier Pertz has recently discovered in an old MS. in the Royal Library at Berlin that, even in the year 1291, two Genoese navigators, Teodosio Doria and Ugolino Vivaldi, sailed for a certain distance down the West Coast of Africa. Their ships were called *Sant' Antonia* and *Allegranza*, and the last-mentioned name has, indeed, remained attached to the most northern of the Canary Islands. It has been erroneously stated in some journals that these Genoese navigators sailed round the Cape of Good Hope.—*June* 20, 1859.

in order to reach the great lake Nyanza, the position of which had been pointed out to him by the Arabs, who asserted that it was much longer and larger than Tanganyika, from which it is separated by about 200 miles. In this journey Captain Speke, accompanied by his faithful Belooches, passed through the district where the chief iron works of the country are carried on; the native blacksmiths smelting the ore with charcoal.

The great lake Nyanza was found to occupy the position assigned to it by the Arabs, and the E. longitude being very nearly that of Kazé, viz., 32° 47′,* its southern end was fixed at 2° 30′ S. lat. Ascending a hill and looking northwards, the enterprising traveller could discern nothing beyond the islands termed Ukerewe, but a vast interior sheet of water, which, according to those Arabs, whose information had hitherto proved correct, extended northwards for upwards of 300 miles. Captain Speke, who estimates the breadth of this internal sea at 90 miles near its southern end, further ascertained that it is fed not only by streams flowing from the mountains which separate it from Lake Tanganyika, but also by other streams, many of which meandering in the lower plateau to the west of the lake, constitute, like the internal rivers described by Livingstone, a watery network which when supersaturated by the rains burst and overflow the country.

"Seeing that this vast sheet of water extends due northwards, ascertaining by his thermometer that it was nearly 4,000 feet above the sea, and knowing that its meridian was nearly that of the main course of the White Nile, Captain Speke naturally concludes that his Nyanza is the chief source of that mighty stream on the origin of which speculation has been so rife. This view seems to coincide with the theoretical speculation laid before this Society by myself in preceding years, and is in accordance with the data worked out by Livingstone, of a great interior watery plateau subtended on its flanks by higher lands, and from which interior plateau the waters escape to the sea by favoring depressions.

"The physical configuration of the land to the east of the great Nyanza Lake is indeed strongly in favor of this view. On that side, and at a distance of about 200 miles from its banks, the eastern coast range of Africa rises from 6000 feet in the latitude of Zanzibar (where it was passed by our travellers) into a lofty range or cluster, of which Kilimanjaro forms the southern and Kenia a northern peak.

"If the assertion of Rebmann and Krapf be accepted, that perpetual snow lies on those mountains, though the able critical essay of Cooley† had induced me to suppose that these mission-

* Lunar observations were made at this station.

† *See* Cooley's "Inner Africa Laid Open," p. 126.

aries might have been somewhat misled, the summits of these mountains must have an altitude of upwards of 18,000 feet. At all events it is granted that they are the highest points of this coast range. Now, whilst streams descending from the western flank of Kenia (Kilimanjaro is too far to the south) may probably be feeders of the great Nyanza Lake, which occupies a long lateral north and south depression in the plateau on the west, we know from its meridian as now fixed, that the direction of this fresh-water sea points directly to Garbo, the spot in latitude 3° north reached by M. Ulivi, as related by Brun-Rollet, a Sardinian, who had established a trading post at Belenia in latitude 4° 50′ north, on the White Nile in 1851. The north and south direction of the Nyanza, which Speke believes to reach from south latitude 2½° to 3° 30′ north latitude, brings us in fact beyond the Garbo of Ulivi and Brun-Rollet.*

"The variations which occur in the height of the waters at different seasons, in the interior plateau-country surrounding the great lake, were strikingly described to Captain Speke by the Arabs, when they assured him that at one season of the year the water lilies were so abundant as to enable the traveller to pass over a wide river by treading on their broad and thick floating leaves, showing how flat the country must be, and how sluggish are the streams.

"Let us hope that when re-invigorated by a year's rest, the undaunted Speke may receive every encouragement to proceed from Zanzibar to his old station, and thence carry out to demonstration the view which he now maintains, that the Lake Nyanza is the main source of the Nile. Considering the vast difficulties which beset the traveller who attempts to penetrate southwards by ascending the Nile, it seems to be preferable that the effort should be made from Zanzibar, where Captain Speke is sure of being heartily supported by the Sultan, and whence, taking men on whom he could rely, he can certainly calculate on reaching the Lake Nyanza in good plight, for that zone of Africa which he has passed through is now ascertained to be occupied by a much more tranquil people than those of the countries north and south of it.

"On former occasions I contended that the periodical overflow of the waters from the internal fresh-water lakes was explicable by the fact, that at certain periods of the year, differing of course in different latitudes, the rain-fall of several months would at last so supersaturate the interior plateau-lands and lakes as to produce periodical annual discharges. That the lofty mountains of

* M. Jonard has analyzed and compared the discoveries of M. Brun-Rollet, who gives some information derived from De Angelis, who resided at Belenia in 1851, which is worthy of attention. But speculations founded on such uncertain data are of no great value.

the coast range, of which Kenia is the chief peak, may throw off certain feeders of the White Nile, just as the mountains of Abyssinia feed the Blue Nile, must probably be the case; but whilst it may be admitted that little snow may occupy the peaks or summits of Kilimanjaro and Kenia, I am of opinion with the learned Cooley* that the elevation and mass of these mountains are not such as would sustain a vast range of snow and ice, the melting of which would account for the annual rise of the Nile. Even if it be assumed that this is really a snowy chain, the exact periodical rise of the Nile could never be caused by a periodical melting of its snows, since the power of the sun under the Equator is so nearly equable throughout the year, that it must operate in filling the streams which descend from the mountains with pretty much the same amount of water at all seasons. The great phenomenon of the periodic rise of the Nile is, it seems to me, much more satisfactorily explained by the annual overflow of a vast interior watery plateau, which is, thanks to Captain Speke, ascertained to have an altitude much more than adequate to carry the stream down to Khartum, where the Nile is believed to flow at a height of less than 1500 feet above the sea; and as the river below that point passes through an arid country, and is fed by no lateral streams, it is to the southern, central, and well-watered regions that we must look for the periodic supply.

"On consulting Captain Speke respecting the rainy season of that part of the interior of Africa which lies between Ujiji and Unyanyembé, I find that in about east longitude 30° and south latitude 5° the rains commence on the 15th November and end on the 15th May, during which period of six months they fall in an almost continuous downpour. Farther northward, where the Lake Nyanza lies, the rainy season, in the common order of events, would commence, he supposes, somewhat later, and probably at a time which will account for the periodical rise of the Nile at Cairo on the 18th June. In support of this view Captain Speke states that the river Malagarazi, which drains the surplus waters from the southeast slope of the mountains between the Lakes Nyanza and Tanganyika, when first crossed by the expedition, was within its banks, but on the 5th June it had quite overflowed them and constituted a stream 100 yards broad, run-

* This acute scholar has shown his power as a comparative geographer by a close analysis of the *quæstio vexata* respecting the Nile of the ancients, and shows that the true Nile of Ptolemy was the Blue Nile, which descends from the mountains of Abyssinia. He also shows that the great lakes of the Nile of Ptolemy are at the Equator—a view now confirmed by the researches of Speke. As to Kilimanjaro, he says it is "an insulated mountain in a sea-like plain, and on a fifth scale of the magnitude required for maintaining perpetual snow near the Equator." *See* also his work "Inner Africa Laid Open," in which he explains the existence of a great sea or lake in the interior of Eastern Africa.

ning westwards into the depressed lake of Tanganyika. Now, as according to the Arabs, and other intelligent men with whom he conversed, the whole region to the northward of the mountain in question, *i. e.* beneath and to the north of the Equator, is an extensive marshy plateau, intersected by some large and innumerable smaller streams, all feeders of Lake Nyanza, we have only to suppose that at the *close* of the rainy season the great discharge occurs, and we then have in these data strong grounds for believing, that the theory which I ventured to propound to this Society as the best explanation of the overflow of the Zambesi of Livingstone, as well as of the Congo and other African rivers, will also be found to be applicable to the Nile.

"In concluding this notice of the labors destined to clear up the problem of the real sources of the Nile, I must express my thanks to Mr. M'Queen for his efforts to collate all the data concerning the ascents of the White Nile from the expedition sent by Mahomed Ali in 1839 to that of Don Angelis, which Brun-Rollet accompanied in 1851, and when the party reached 3° 50′ north latitude, 31° east longitude. Adding to information obtained from natives and Arabs, and citing Lucan and other ancient authors to the same effect, Mr. M'Queen contends that a lofty mountain to the southeast of the cataracts of Garbo, the last station of Brun-Rollett and his companions, which must be Kenia, is the chief feeder of the White Nile, and that the river Tubesi, spoken of by the African King of Bari, is really the Tumbiri heard of by Dr. Krapf.

"Now, even if this view be sustained, it seems to me to be quite compatible with the fresh knowledge obtained by Captain Speke, and his inference, that the Nyanza is the chief feeder of the White Nile. For the southern extremity of this great inland lake is but 2½° south of the equator, whilst its western shore is probably not more than 150 miles from the lofty mountain of Kenia. Hence, seeing that Nyanza is about 4000 feet only above the sea, and that the eastern mountains, under the equator, are much higher, there is every probability that this vast sheet of water may be fed from the east by streams flowing from Kenia, as it is ascertained to be supplied from the southwest and west by other rivers flowing from the mountains, which separate this high sheet of water from the depressed Lake Tanganyika.*

"If then it should eventually be proved, that the Lake Nyanza contributes its annual surplus waters to the White Nile, so

* Mr. Edw. Heneage informs me that Botero, in his "Relationi Universali" (Venice, 1640), says that the eastern Nile flows out of a lake 220 miles long, situated under the equator; and he places the sources of the western branch of that river S. lat. 9°, close to the sources of the Zaire or Congo, and what may also be intended for the origin of the Zambesi.

may it then be fairly considered as the main source of the great river; the more so when we see that its southern end is farther to the south, or more remote from the embouchure, than any other portion of the Nilotic water-parting.* On the other hand, the high mountains which flank the great stream on the east, and probably supply it with some of its waters, may by other geographers be rather viewed as the main and original source. These are the only remaining portions of the great problem which have to be worked out—a problem which it has been the desideratum of all ages to unravel, and one which, according to Lucan, made Julius Cæsar exclaim, that to gain this knowledge he would even abandon the civil war†—a problem which Nero sent his centurions to determine, and which, by the last discovery of Captain Speke, seems certainly now to approach nearly to a satisfactory solution."

WARREN'S MEMOIR TO ACCOMPANY A MAP OF THE WESTERN TERRITORY OF U. S.—We have already referred to the admirable map by Lieut. G. K. Warren, U. S. Topog. Eng., prepared to illustrate the result of the various expeditions of the government to the teritory west of the Mississippi river.‡ We have now received a volume from the pen of the same officer, illustrative of the map. It is printed from the advance sheets of the eleventh volume of the Pacific Rail Road Surveys. This memoir is not limited to a description of the map, and an account of its method of compilation. It gives in a condensed form a review of all the exploring expeditions in the West since 1800.

The first period extends from 1800 to 1832, beginning with the travels of Lewis and Clarke and concluding with those of Hardy, Ross Cox, Allen, and Schoolcraft.

The second period, from 1832 to 1844, includes the exploration of Bonneville, the early discoveries in Great Salt basin, Nicollet's hydrographical survey of the upper Mississippi, the beginning of Frémont's travels, and other reports and maps of army officers, the topographical engineers.

The third chapter is devoted to more than twenty expeditions, of greater or less importance undertaken between 1843 and 1852, almost exclusively under the patronage of the U. S. Government.

* Although both White Nile and Blue Nile are fed by many affluents, the remarkable physical feature of the great stream below their junction is that in a course of 1200 miles it is not increased by the addition of any lateral waters. On this feature, as well as on the parallelism of its course to the great N. and S. depression of the Red Sea, on the fertilizing powers of its waters, and on the periodicity of its flood, the reader will do well to consult the article "Mediterranean Sea," Edinburgh Review, vol. cvi., which is from the pen of our accomplished associate Sir Henry Holland.

† "Spes sit mihi certa videndi
Niliacos fontes bellum civile relinquam."—LUCAN, *Book* 10.
(As quoted by Mr. M'Queen.)

‡ This Journal, vol. xxvii, 386, 1859.

In 1852, the various important Surveys for the Pacific Rail Road commenced, and a review is given of their several routes and objects. To this historical report, succeeds a statement of the method of completing the general map before alluded to and some remarks on the topography of the region west of the Mississippi River.

Four reduced copies of early maps of the territory west of the Mississippi are included in the Memoir; first, of a map published with Winterbotham's History in 1796; second, of Rector and Roberdeau's map, 1818; third, a part of Finley's North America, 1826; and finally, of Bonneville's map which appeared in 1837.

The Memoir and the Map taken together are an important accession to our knowledge of the physical geography of this continent and will be of constant service not only to men of science, but to statesmen and all others who are interested in the structure and resources of the immense territory which lies to the west of the Mississippi river. In this connection, we may call attention to the tenth volume of the surveys of the Pacific Rail Road which has just been distributed, containing Part III. of the report on "Zoology," prepared by Prof. Spencer F. Baird of the Smithsonian Institution.

HISTORY OF THE DISCOVERY OF AMERICA. ATLAS OF KUNSTMANN, SPRUNER AND THOMAS.—In striking contrast with the work we have noticed by Lieut. Warren and its illustrations of recent discovery, we may mention the republication of early maps of this continent (chiefly the Atlantic coast,) which has been just made under the auspices of the Bavarian government. A few copies of this truly magnificent atlas have been received by Messrs. B. Westermann & Co., in New York. In place of comment of our own, we translate from the Berlin *Zeitschrift für allgemeine Erdkunde*, the following condensation of the plan of the compilers.

F. Kunstmann, K. v. Spruner and G. M. Thomas have published an Atlas on the history of the discovery of America, which consists of thirteen most interesting sheets printed in fac-simile from those most valuable chartographical documents, which are found in the Royal Library, the Library of the University and the Military Conservatory at Munich. F. Kunstmann in his learned treatise "Die Entdeckung Amerika's, which precedes the text explanatory to the charts, says, "The charts commence in the 14th century, when they first appear as the product of independent inquiry, and follow the progress of the voyages of discovery, the results of which are for the most part deposited in them. Our knowledge that the Azores were discovered in the 14th century, we owe solely to the charts, as we have no other historical accounts concerning them. The history of the Canary Isles which is at first but fragmentary, is also completed by them.

They also enlighten and increase our knowledge in relation to the discoveries in America generally. In these charts we also have original records for the history of the voyages of the separate nations. They commence with the voyages of the Italians, who first set out independently, then in the service of Portugal, Spain and England, leaving us those grand drawings of the globe, which were continued and finished by other nations. These accordingly preceded the systematic descriptions of the world, which furnished us with but poor and scanty information in regard to the discovery of America, although the charts had already presented an almost complete picture of what was then known." Of the thirteen sheets of the atlas the first five relate to the time of Magalhaens's voyage of discovery down to its completion; the following eight explain the history of discovery to the end of the 16th century. We will here attempt to show the importance of this publication by a short extract from F. Kunstmann's explanations to the charts.

The first sheet the contents of which Schmeller had made known in his academical treatise, "On several older Sea-Charts in Manuscript," (December, 1843)—is written in the Portuguese language and bears the name of its author at its head, Pedro Reinel a fez. Barros (Dec. 1, lib. 3, c. 12) mentions a Pedro and a Rodrigo Reinel. The former was sent in 1487 to the negro-chieftain Mandimansa at the Gambia. Rodrigo is mentioned in the same year as a merchantile agent in the Oasis Ouadan on his way from Arguim to Timbuctu. In the following century, the Portuguese Sebastian Alvarez, mercantile agent at Sevilla, mentions in his account of the enterprises of Magalhaens (made July 18, 1519 to King Emanuel of Portugal,) two Reinels, father and son, omitting however their christian names. "I saw, he says, the Moluccan Islands on the globe and the chart, (en la poma y carta) which Reinel the son has made here; both were yet incomplete, when his father came to him, who finished them and put the Molluccan Islands in." For this master were also made all those charts which Diego Ribero completed, who was the assistant and probably also the pupil of the older Reinel; hence the conformity in that part of Pedro Reinel's chart which represents North America, with the northern part of America in Diego Ribero's chart. The former contains in the new world, only the eastern coast of Newfoundland and our present Labrador up to Hudson's Bay, in a continuous drawing agreeing with the report given by the Venetian ambassador Pasqualigo, (October 19, 1501) on the second voyage of Caspar Cortereal in the year 1501, from which but two Caraveles with sixty natives, without Cortereal, returned. Soon after this voyage the above chart was probably worked out in Portugal.

The second chart represents the notions of that period in which North America was believed to consist of a number of islands between which, it was hoped, a passage might be found to the Mollucas. We find here the "Terra de Corte Reall" completely separated and the terra de lauorador (Labrador) as a complete island. North of Great Britain the "Terra de Uresland" (Vresland, Frisland) is situated, a name which according to Zahrtmann is derived from Ferris land as English mariners called the Faroes. Besides this, the sheet contains the West Indies (le Antilie) the northern and part of the eastern coast of South America, the latter up to Rio de Cananor, as according to Peschel, it is often written instead of Rio de Cananea, on the Italian charts published since 1507, which were copied after Ruysch.

On the third chart, which only marks the discoveries of the Portuguese, of which the Spaniards take no notice, Labrador, (or Groenland, and the "Terra de Corte Reall" appear also as separate continents in accordance with the discoveries of C. Cortereal in his two voyages in the years 1500 and 1501. As a third continent, is seen the eastern coast of South America from Cape Roque up to R. Cananea, in conformity with the results obtained by the coast-voyage in the year 1501, in which Amerigo Vespucci took part.

The fourth chart represents North America, Labrador, Newfoundland under the name Bacalnaos instead of Bacalhaos, and the country of Corte Real as all three separated from one another by straits. In Central America the Peninsula of Yucatan appears, and the chart must therefore have been finished after the year 1517. Honduras with the islands lying before the same, the Isthmus with the Pacific coast, the latter however without nomenclature, and finally the West India Islands. The South American coast, richly furnished with names, extends southerly over the R. Cananea up to C. Santa Maria, comprising a region which was not drawn upon the former sheet, which however in Kunstmann's opinion was discovered already in the year 1501; others say, that Juan de Solis discovered it first. The original of this chart in the Military Conservatory, contains also the Eastern Hemisphere, which is not communicated in this atlas for want of space. Here the Moluccan isles are noted with the addition: "ilhas de maluqua donde vem ho cravo." The fleet which Albuquerque had sent out to open the trade with the Moluccan Islands, first reached them early in the year 1512.

The fifth sheet has been taken from an atlas which consists of seven charts and formerly belonged to the Monastery of Metten but now is preserved in the Royal Library at Munich. One chart of this atlas bears the inscription: *Vesconte de Maiollo civis Janua composuy hanc cartan in Janua*, with the year 1519, which

probably also indicates the time of origin of the other six sheets. Majolo is situated in the papal dominions, and a Jacobus de Majolo condam Vesconti, probably a son of the one mentioned above, presents himself as the author of a chart: "Janua anno Domini 1551 die 19 marsi." The chart taken from this atlas by Kunstmann commences on the American continent with the coast of Honduras, upon which the Rio de Cama Roma (Cape Cameron), and the Bay of Xagoa, both discovered in 1508, are named. Besides these the four great Antilles are noted upon it and a considerable number of smaller islands. The South American continent is also already drawn out up to the Cape of St. Maria and is richly furnished with names.

The following charts belong to a period after Magalhaens's voyage. Sheets six and seven are taken from an atlas of thirteen charts, which is kept in the Library of the University, and which can only have been drawn after the year 1534, as Cuzco is mentioned in it.

The sixth sheet commences at the eastern coast of America with the terra "che descobrio steuen comes," i. e., the country which Estevan Gomez had discovered in 1525. It contains the *terra de lecendiados*, i. e., the coasts of Pennsylvania, Virginia and Carolina, which the Licentiates Lucas Vasquez de Aillon and Matienzo are supposed to have already discovered in 1520; and also Mexico under the name *Temistitan vel Misicho*;—the central American coast, near which Yucatan is represented as an island;—the Antilles and the northern coast of South America. In the south, we perceive Magalhaens's Strait (Strictum de Magellano) with the harbor of St. Julian and Fireland, and from the western coast of America is seen a continuous stretch of Colao Provintia and Peru Provintia in the south, up to California in the north, which latter is represented as a peninsula. In the remoter part of the Pacific Ocean, several of the east Asiatic islands are noted as Dshilolo, Timor, Sumatra, and on the eastern side of Asia, Bengala Civitas and China Civitas.

The seventh sheet, taken from the same atlas, represents the countries on both sides of the Atlantic Ocean: the eastern coast of America from Newfoundland (terra de bacalaos) in the north, to Magalhaens's Strait, inclusive of that part of the Brazilian coast which is wanting on the former chart, and the coast of La Plata south to the Strictum de Magellano and the northern coast of the Fireland with the Campana de Roldan, which is called after a German companion of Magalhaens. As on the former sheet so also here the west coast of Patagonia and the coast of Chile are wanting.

The sheets eight to twelve are taken from the atlas of Vaz Dourado, the original of which with the year 1571 is found in the Archives at Lisbon. The Royal Library at Munich possesses

a much more splendid copy of the year 1580, which however deviates in many respects from the original. The eighth sheet furnishes a complete drawing of the coast of South America south of the mouth of the La Plata with Magalhaens's Strait, on which the Cape *dellas virgines* and the Fireland, which is divided into several islands, are named. The western coast of South America is abundantly furnished with names. The ninth sheet is equally rich and contains the northern half of South America; the tenth sheet has Central and a part of North America; sheet eleven gives the region where the River St. Lawrence empties into the sea, Newfoundland as an island (a part of its eastern coast appearing as a separate isle) together with the Terra de Lavrador, north of the River St. Lawrence; and finally sheet twelve gives the western coast of North America, including the peninsula and the Gulf of California.

The last sheet of the atlas reproduces an old English chart with the inscription "Thomas Hood made this platte 1592." The original belongs to the valuable collection of the Duke of Northumberland, Robert Dudley, who died 1639 at Florence in Italy. The part of America which is here represented, comprises the great Antilles, the Bahama isles, the coast of Yucatan, Mexico, Florida and Norumbega, which latter name is retained for a considerable part of the American coast south of the River St. Lawrence.

The atlas therefore comprises a great number of most valuable documents in relation to the history of the discovery of the new continent. The execution of the different sheets is so excellent, that the whole work may justly be called splendid. The text accompanying the same, contains, besides Kunstmann's comments above mentioned and the explanatory notes to the single charts, a log-book, first edited by G. M. Thomas, which was taken from a ship of Drake's third expedition (Aug. 28, 1595 until May 10, 1596,) and is preserved in the Royal Library at Munich.

THE FATE OF SIR JOHN FRANKLIN.—The following letter has been addressed to the Secretary of the Admiralty by Capt. F. L. McClintock, R. N.

"Yacht Fox, R. Y. S.

"Sir: I beg you will inform the Lords Commissioners of the Admiralty of the safe return to this country of Lady Franklin's Final Searching Expedition, which I have had the honor to conduct.

"Their lordships will rejoice to hear that our endeavors to ascertain the fate of the 'Franklin Expedition' have met with complete success.

"At Point Victory, on the northwest coast of King William's Island, a record has been found, dated the 25th of April, 1848, and signed by Captains Crozier and Fitzjames. By it we were

informed that her Majesty's ships Erebus and Terror were abandoned on the 22d of April, 1848, in the ice, five leagues to the N.N.W., and that the survivors—in all amounting to one hundred and five souls, under the command of Captain Crozier—were proceeding to the Great Fish River. Sir John Franklin had died on the 11th of June, 1847.

"Many deeply interesting relics of our lost countrymen have been picked up on the western shore of King William's Island, and others obtained from the Esquimaux, by whom we were informed that, subsequent to their abandonment, one ship was crushed and sunk by the ice, and the other forced on shore, where she has since been, affording them an almost inexhaustible mine of wealth.

"Being unable to penetrate beyond Bellot Strait, the Fox wintered in Brentford Bay and the search, including the estuary of the Great Fish River and the discovery of eight hundred miles of coast line, by which we have united the explorations of the former searching expeditions to the north and west of our position with those of James Ross, Dease and Simpson, and Rae to the south, has been performed by sledge journeys this spring, conducted by Lieutenant Hobson, R.N., Captain Allen Young and myself.

"As a somewhat detailed report of our proceedings will doubtless be interesting to their lordships, it is herewith enclosed, together with a chart of our discoveries and explorations, and at the earliest opportunity I will present myself at the Admiralty to afford further information, and lay before their lordships the record found at Port Victory." D. C. G.

Yale College Library, Oct., 1859.

Art. XLV.—*Correspondence of Prof. Jerome Nicklès, dated Nancy, August 20th*, 1859.

Necrology.—Cagniard de Latour.—This physicist died lately in his 82d year. He was born in Paris, March 31st, 1777. He entered the Polytechnic School in 1794—the year of its foundation. Two years later he left this school to enter the corps of hydrographic engineers. He soon however quitted this duty to devote himself exclusively to scientific labors. Nevertheless he accepted in 1811 administrative duties in connection with his former profession. He had already made himself known by several practical inventions--among others the adaptation of the Archimedan screw to the purposes of a blowing machine. This apparatus is still known in France by the name of *Cagniardelle*, in honor of the inventor.

In 1814, at the time when France was oppressed by the European coalition—Cagniard de Latour invented a process for polishing cannon powder, which passed immediately into use, with the best results.

About the same time he invented a portable mill for grinding wheat in camp. It weighed only seven pounds, and was employed during the disastrous campaign of the Hundred Days.

In 1818 he devoted himself to gas illumination, and largely aided the general introduction of this important industry into France. It was however in 1819 that he made his most important and beautiful invention, the *Sirene*, by which he was able to determine with accuracy the vibrations of sound. This instrument he employed upon various gases and liquids. He discovered thereby the origin of what is called technically *timbre*, that quality in sound by which instruments are distinguished from each other although sounding in the same pitch and with like intensity.

In 1822 he published his researches upon the effect produced by heat upon bodies under great pressures. He deduced from these researches the fact that a liquid may be converted into a vapor occupying the same or but little more space than the original liquid, a result distinguished by Faraday as "*the law of Cagniard de Latour.*" These experiments led to the discovery of the methods of liquefying gases.

By heating wood with steam under high pressure he obtained a tarry product resembling coal. This experiment has been repeated recently under better conditions and real coal has been thus obtained.

Cagniard de Latour is the author of the physiological theory of fermentation, which refers the chemical phenomena to the vital power of a confervoid plant. The dial-faced balance: a machine for estimating the flight of birds: the filiform hydraulic pump and the "canon-pompe," are also his inventions. Moreover he is the author of published researches on the change of volume in bodies submitted to different degrees of tension (traction). Lastly, in 1826 he constructed the Suspended Aqueduct of Crouzol, nearly two hundred meters long, and without intermediate support.

Disinfection and dressing of wounds.—For several weeks the scientific and medical world has been greatly interested by the introduction of a new and remarkable topical application for dressing wounds. Official experiments on this dressing have been made at "*la Charité*," where cancers and other affections of that kind receive special attention. The distinguished surgeon Velpeau, after experiments with this disinfectant on suppurating wounds in a putrid state, has reported favorably to the Academy of Sciences. We extract some passages from his report.

"A large mammillary ulcer with mortification of the skin was treated with the topic both in powder and in pomade. The suppuration diminished and the odor disappeared. At the same time the affected surface became cleansed and the mamma without pain.

In the case of a woman with a vast cancerous ulcer eating away all the left side of the chest, the odor of purulent pus after two daily applications disappeared.

A young man was treated whose hand was scalded by a steam boiler and mortification had supervened, involving nearly the whole of one finger. On Saturday morning this finger was in a complete state of mortification and gave out a disgusting odor, it was dressed on the morning and evening of that day with the powder in question; the bad finger was dried up immediately, the odor disappeared, and the mortification ceased.

Thus in wounds as well as on fetid animal matters disconnected with the body this topic disinfects them at once, having no trace of odor beyond a slight and not disagreeable smell of bitumen.

He adds that this mode of disinfection occasions neither pain, irritation, swelling or inflammation; it also appears rather to favor than otherwise, the progress of granulation and cicitrization; there is therefore no inconvenience in applying it to various ulcers, sores and wounds requiring to be disinfected."

Results equally favorable have been obtained at the veterinary establishment at Alfort.

The Major General of the French army in Italy, anticipating these reported results gave orders for the use of this topic immediately for the relief of the wounded. The success of this treatment has been communicated by Marshall Vaillant to the Academy. The report details the successful treatment by this means of gangrened sores upon twenty wounded Austrians in the hospital at Milan. These cases the physicians assert were of the worst possible character, and the success immediate and complete.

What is this remarkable topic? *It is a mixture of* 100 *parts of plaster of Paris with* 3 *parts of coal tar.* The mixture is easily made in a morter. Its application is made by mixing the powder with olive oil. The application either of the powder or the pomade occasions no distress even if placed in direct contact with the surface. The treatment has the double advantage of disinfecting and also absorbing the pus—thus dispensing with the employment of lint—as the late experience in Italy has abundantly proved.

This simple mixture was originally prepared for the disinfection of artificial manures. Its author is Mr. Ed. Corne, veterinary surgeon at Libos (Lot and Garonne). Mr. Demeaux, one of his medical friends, conceived the idea of applying it to the disinfection of sores, of purulent liquids and the debris of anatomical dissections. Human ordure in full decomposition and giving off an infectious odor has by this powder been instantly transformed into a odorless earthy mass.

The communication of Dr. Velpeau gave rise to an important discussion which we will now consider. M. Bussy at once recalled the fact that charcoal powder, the Boghead coke, creosote and alkaline hypochlorites have for a long time been used as disinfectants. M. Chevreul next called attention to the fact that in the last century Dr. George Berkeley, Bishop of Cloyne, had published a work on the virtues of tar-water, in which he speaks of this agent with enthusiasm. It was esteemed by him as a specific also particularly against ulcers, virus and the scurvy.

More than twelve years ago Dr. Herpin of Metz proposed a disinfecting mixture of plaster and carbon. Dumas reminded the Academy that one of its prizes was a few years since awarded to Mr. Sizet, who showed all the metallic salts which could be used with advantage in disinfection—who also added that the properties of these disinfectants were much exalted by the addition of a small proportion of coal tar. These experiments have also been confirmed elsewhere by Mr. Boussingault, without, it is true, a special reference to the treatment of sores and ulcers.

Coal tar has been used in England for disinfecting dead animals for

the uses of rural economy. The use of coal tar has also been advised for the dead on the battle field.

Dumas added that having often sought an explanation of these facts he had found it in the fact illustrated by Schoenbein that the vapor of turpentine when mixed with air produced an abundance of ozone. He thought that the vapor of coal tar oil might equally ozonize the air. In this case the odorous mixtures would be immediately burned by the ozonized oxygen and the putrid odor rapidly destroyed.

If coal tar really produces this action it is necessary, according to Dumas, to distinguish three effects. 1st, the destruction of the infectious vapor or gas by means of ozone arising from coal tar. 2d, the action of the plaster in preventing the production of new infectious gases by the solidification of the liquids present. 3d, the point of arrest set to the development of putrefactive process by any of the products contained in coal tar, and especially the phenic acid which in the smallest traces in the form of phenate of soda secures the preservation of animal matters in free air.

On the odors of perfumes.—On occasion of the discussion which we have just recorded, Mr. Chevreul offered his ideas upon the mode of action of odoriferous substances. This discussion was intended to recall the publications which this distinguished chemist has made during the past thirty years—researches made specially to trace odors to their material causes. He reviews in the following manner the action by which bodies exert their odors when properly mixed with other odoriferous materials. 1st. Bodies themselves odorant disguise the odors of other substances, as a strong light overpowers a feeble one. 2d. Bodies being themselves odoriferous act in the manner of an acid in neutralizing a base. 3d. Solid bodies may act by capillary affinity to absorb odors, as is the case for example with charcoal. 4th. Other bodies act by altering the constitution of the odorant substance, producing new compounds either odorless or nearly so. Such is the action of moist chlorine or oxygenated water. 5th. Lastly, the action may be two-fold, as in the case of chlorine and ammonia, decomposing one portion and neutralizing the other without decomposition.

Neutralization includes the largest class of cases; thus the volatile odorous acids are neutralized by alkalies to form odorless salts. Ammonia loses its odor when united to an acid. The odors in such cases are truly neutralized, since displacing the acids liberates again the odors each in its own character. Examples of the destruction of odors are numerous and well known to chemists. Sulphydric acid, for instance, is at once decomposed by chlorine and consequently disinfected. Ammonia by the action of chlorine offers an example of both neutralization and destruction of odors, because at the same time we have decomposition of one part of the base and the neutralization of another part by the chlorohydric acid formed.

M. Chevreul proposes to define odors by means of a scale, analogous to our notation of sounds, or for gradations of color by the chromatic diagram (which last device we also owe to this *savant*). The great obstacle to this plan is the difficulty of employing the sense of smell as we employ that of sight or hearing, a difficulty much increased by the toleration which the smell soon acquires to odors—becoming '*blase.*'

In 1830 he endeavored to take account of the changing odors exhaled by the woad vats during evaporation, if possible to define exactly the kind of odor appropriate to each condition of the vat. He reached no positive results although he detected in the dye stuff bath *five* perfectly distinct odors; the odor of ammonia, a sulphurous odor, a metallic odor, an aromatic odor, clinging for many months to the woolen stuffs which had passed through the woad vat, and lastly, the odor of a volatile acid analogous to that of animal matters in decomposition. M. Chevreul hoped to detect in these odors of the dye vats symptoms to guide the dyer in his art, as the physician finds new indications in his knowledge of symptoms depending on the chemical nature of organic solids and liquids, if these symptoms can be certainly recognized by their odor. Thus he did not shrink from exposing himself to the most repulsive odors of the organism to reach his results. Having often heard the odor of a cancer spoken of as characteristic he examined it and recognized it to a compound of—1st, an ammoniacal odor turning blue a reddened test paper. 2d, a feeble butyric odor. 3d, a heavy odor which is familiar in the 'trying out' of suet or lard. No specific odor exists then in cancers, since the three odors recognized coexist in *non-cancerous* matters which the disease alters. He recognized these matters in the odor of pus and other products of animal origin, and he also detected in them a sulphurous odor and a smell of fish, due probably to a compound ammonia.

To all these odors he adds what he calls the stale-nauseous (*fade nauseabonde*) which appears in well-water that has stood some days in a vessel in which have been placed egg shells impregnated with albumen.

[We may be permitted to add to these interesting facts some others which we submit to the distinguished author of the chromatic circle and researches on the fatty bodies.

1. If an odorous substance can be neutralized or destroyed by another odorant body there are others destitute of odor which by union produce odorant substances.

(To this class of odorless bodies belong O, S, Se, Te, C, H, As, Az, and we might add P, which is oderless unless combined.)

2. Likewise there are odorless bodies which have become odorant by union with others endowed with odor.

It is thus with oxalic, malic, butyric, racemic, citric, sorbic (the acid recently discovered by Hoffmann), boric, silicic acids, all odorless, which however produce with the elements of alcohol, ethers more or less aromatic.

3. It is necessary to distinguish those bodies which act mechanically on the olfactory membranes (e. g., ClH, FlH, BrH, IH, and the vapors of NO_3+HO, SO_3HO) from those which exert a physiological influence (for example, Cl, Br, I, NO_4, SO_2, the hydrocarbons, the essential oils, &c.).

4. It is necessary also to distinguish bodies having an odor proper, that is, an odor which exists when they form compounds with other bodies (for example, arsenic). The arsenical odor is recognized in AsH^3, $AsBr^3$, and in the cacodyl series. Tin is another example. The odor of tin characterizes a large number of stannic compounds. Sulphur: thus SO_2SH, S_2C, SNH_3, SCl, &c., are distinguished by a more or less sulphurous odor.

We might also mention napthaline, benzoin, and other hydrocarbons and organic radicals.

We see that this group of bodies characterized by a peculiar odor, embraces those elements which, like sulphur, arsenic and phosphorus, are destitute of odor, that is, their odor is manifest only in combination. If we examine these phenomena we observe (*a*) that elementary bodies are usually destitute of odor; (*b*) that in general the least odorant compounds are oxygen compounds; (*c*) highly odorant compounds are usually those containing hydrogen. These seemingly singular facts may to a certain extent be explained when we remember that in general chemical compounds become less volatile as they fix oxygen, which by union with hydrogen they become more volatile. But these considerations do not explain all; they do not tell us why CO and CO_2 are odorless gases, while $C_{12}H$, $C_{26}H_8$, $C_{12}H_6$, &c. &c., are odorant.

Moreover the perfumes properly so called, as musk and the aromatic essences, rose, lemon, orange, bergamot, lavender, &c. are eminently hydrogen compounds. They are not all volatile and some of them may be exposed to the air for years, exhaling odor all the time, with no sensible loss of weight. Among these are the perfumes isolated by Milon in 1856.* The cause of odors is not referable exclusively to the phenomena of volatility, although as a general thing the odor of most bodies is developed when they are volatilized.

Hydrogen must be considered, par excellence, the exciting cause of odors. This element possesses above all other substances the peculiar property of developing odors even with odorless bodies, as N, C, Se, Te, P, &c., and a great number of compounds, of these and other elements.

Oxygen on the other hand appears to act the chief part in the perception of odors; it seems indeed proved that odors are not recognizable where there is not oxygen in the air to bathe the olfactory membranes.]

Humboldt Foundation.—[After mentioning this foundation, of which we give a more detailed notice on a subsequent page of this volume, our correspondent adds:—] We remark that this foundation resembles the Society for Aiding the Friends of Science, with this difference, that the Humboldt Foundation proposes particularly to aid rising talent and to encourage scientific explorations, while the Society for the Friends of Science sustains scientific men in declining health and comes to the relief of their widows and orphans. The two organizations are therefore complementary to each other, and are worthy to go on side by side.

Photography by Carbon. Concours for the prize founded by the Duke of Luynes.—We have for some years past discussed this photographic question—the object of a prize established by a distinguished amateur, the Duke of Luynes. It is required to discover a method by the use of carbon alone, neglecting salts of gold, silver, and other metals, to produce photographs, this being the only material which submitted to the test of time has transmitted to us without change records almost 3000 years old. The Concours has been held; but unfortunately the Commission of the Photographic Society, to whom it was referred, are unable to announce a full success and the trial has been adjourned for three years.

* This Journal, July, 1856, p. 109.

Many persons contested the prize. The desideratum is to obtain a coating of carbon in a manner analogous to that from silver or gold, namely, by reduction. But chemistry as yet has failed to discover a process for the reduction of carbon compounds, and photographers have resorted to animal black which they have applied in any convenient manner to plates previously exposed to the sun. We give a *résumé* of the new results in two memoirs esteemed by the Commission worthy of reward.

Messrs. Garnier and Salmon, the authors of one of these memoirs, cover the surface of paper with a film obtained from an intimate mixture of bichromate of ammonia and albumen. This coating is dried by heat and exposed to the sun in a frame covered by a glass positive. The picture appears in a yellow-brown tint which becomes more intense by a gentle warmth. The sheet thus prepared is fixed on a planchette and covered with finely powdered ivory-black, the coating being made even by a stump of cotton. It is next detached and plunged in common water, the image uppermost, and there gently moved at intervals for a quarter of an hour. The water is then drawn off and the picture served in a bath composed of 5 parts of concentrated sulphurous acid diluted in 100 parts of water, moving it about as before at intervals. After this double process the carbon almost entirely disappears from the lights and clear spaces, while it remains in quantities proportional to the greater or less intensity of action of the light upon the other portions, and thus the proof finally reproduces the positive, but not perfectly, since the lights and half tints are not pure and the blacks lack somewhat of brilliancy and perfectness. But the process is simple and good; it remains only to perfect it.

M. Pouncy, another competitor, operates a little differently, but obtains results equally satisfactory. His process differs in applying the carbon before exposure of the proof to light, the sensitive coating being formed at once, of bichromate of potassa, gum arabic and finely divided carbon, exposed not under a positive but under a negative plate. On removal the plate is placed in a bath of pure water; after five or six hours immersion he washes under a cock of common water and the carbon positive is obtained.

In this process the manipulation is a little easier and more simple. The use of a negative authorized the expectation of a better result, but the exposure is longer than in the mode of Garnier and Salmon, whose use of a positive avoids the chances of accident which attend the negative plates in the hands of the operator.

Messrs. Pouncy, Garnier and Salmon share the prize with Mr. Poiterin, who has the merit of anticipating these photographers, whose methods are only an advance on the process which Mr. Poiterin published in 1856.

Transformation of cellulose into sugar.—We have already spoken in this Journal* of the plan of Pelouze for facilitating the experiment of Braconnot—the transformation of cellulose into sugar—by exposing the woody fibre and dilute acid to high pressure and heat. It is known, and the fact is recognized by M. Pelouze himself, that this idea has been some years since put in practice both by Mr. Weil and also by Mr. Tribouillet, who obtained a patent for the process.

* This volume, page 126.

Transformation of cellulose into parchment or parchment-paper.—It appears that this curious product of the action of concentrated sulphuric acid on bibulous paper, by which means the paper is changed to a tissue very much resembling ordinary parchment, nearly as strong and resisting the action of boiling water, which parchment does not. It appears that this is not a new observation, but was first made known in 1846 by Messrs. Poumarède and Figuier in the Journal de Chemie et de Pharm. for 1847, under the name of *papyrine*. This product however was prepared by aid of an acid of less concentration than is used for parchment-paper and consequently it did not possess all the desirable properties belonging to vegetable parchment, which is susceptible of a multitude of important applications.

Acclimation. The Dromedary imported into South America.—On the 21st of June last the ship "*Splendide*" of Marseilles sailed from the port of Algiers for Brazil, having on board fourteen camels (four males and ten females) selected and purchased by the Society for Zoological Acclimation (*Societé Zoologique d'Acclimation*) to the order of the Brazilian government; this government having decided to test the acclimation of these animals in the sandy provinces of Brazil. Several of these provinces, particularly Céara, during many months of the year are destitute of water, and much resemble in physical characters those regions of Africa and Asia where the camel and dromedary are so eminently serviceable.

The Society of Acclimation, in view of the importance of the case, have sent one of the Vice Presidents of the society, M. Richard (du Cantal), a distinguished zootechnist, to Algeria, between Boghar and Lagonat, in a region inhabited by one of the tribes most distinguished for the number and beauty of their dromedaries. From these herds Richard selected ten females of three to four years old, three males of four years, and one of seven, all in the highest condition, at a cost of 380 francs each. Four Arab camel drivers were also obtained to accompany the animals.

The July (1859) number of the Journal of Acclimation relates all the history of this experiment, to which we refer for the details. But it is to be remarked as regards the prospect of success for this enterprize that a similar experiment has met with success some time since in Texas and Central America, the credit of which is due to Major Wayne of the United States Army.

Bibliography.—There has appeared from the central book depot of Agriculture at Paris

Dictionnaire raisonné d'Agriculture et d'Economie du Bétail par le Dr. Richard, du Cantal, 2 vol. in 8vo.—Richard is one of the Vice Presidents of the Society for acclimation spoken of above. He is best known for his intimate knowledge concerning domestic animals and especially of what in France is called *Zootechny*. The two volumes of his Dictionary are filled with his observations on this important agricultural question.

Mallet-Bachelier, quai des Augustines, Paris, has published—

Recherches sur les Météores et sur les lois qui les régissent par Coulvier Gravier. 1 vol. in 8vo, with numerous plates.—Mr. Coulvier Gravier has brought out in this volume the fruit of forty years of observations on the state of the heavens. We have often found occasion to mention his ob-

servations on shooting stars. This work embraces all belonging to what are called *meteors.* The author is under great obligations to the French government who, on the recommendation of Arago, placed Mr. Coulvier Gravier in a situation to follow his tastes for this sort of observation. This observer does not despair of obtaining the means of predicting the meteoric *periods.* He unfolds his theory in a volume which all can understand, since it is written in a simple style and contains few mathematical formulæ. It shows that the author has obeyed a controlling taste; and his work fills an important gap in astronomical bibliography.

Cours de Mecanique appliqueé par M. Mahistre. 1 vol. 8vo, illustré de 211 figures.—Mr. Mahistre is professor of Mechanics *a la Facultè des Sciences a Lille*, one of the great manufacturing centers of Europe. His admirable work is especially adapted to engineers and to students who are destined to industrial pursuits.

Cours de Mécanique appliquée par M. Bresse. T. 1.—Mr. Bresse is Professor of Mechanics at the celebrated *Ecole des Ponts et Chaussées.* This first volume treats specially of the strength of materials. Like the work of Mahistre, it is particularly adapted to civil engineers; above all it interests the engineers of bridges and roads, who in France occupy so important a rôle, particularly in railroad constructions. Multitudes of these engineers are found scattered over the continent of Europe, especially in Russia, Germany, Spain, Switzerland and Belgium. The science of the pupil gives evidence of the master, who is Mr. Bresse.

Cours d'Electrophysiologie par M. Matteucci. 1 vol. 8vo.—This course pronounced at the University of Pisa is now reproduced in France where the well known high reputation of the author will secure it the attention it deserves.

Cours d'Analyse de l'Ecole Polytechnique par M. Sturm. T. II, in 8vo, 1859.—We have already announced the first volume of this great mathematician, who died some years ago. It is published by one of his pupils, Mr. Proutret, by the choice of the author, and from the manuscript left by him. This work is of special value to professional mathematicians, and to those who are charged with the instruction of this science.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On Torsion and its relations to Magnetism.*—Wiedemann has communicated several interesting papers on torsion and its relations to magnetism, from the last of which we extract the following comparative view, referring to the original paper for the details of the experimental methods employed.

Torsion.	*Magnetism.*
1. The temporary torsions of a wire twisted for the first time by increasing weights, augment more rapidly than the weights.	1. The temporary magnetisms of a bar magnetized for the first time by increasing galvanic currents, augment more rapidly than the intensities of these currents.

2. The permanent torsions of the wire increase still more rapidly.	2. The permanent magnetisms of the rod increase still more rapidly.
3. A much smaller force is necessary to untwist the wire than to twist it.	3. A much weaker counter current is necessary to demagnetize the bar, than to magnetize it.
4. By repeated turnings of the wire, its torsions approximate more and more closely to a proportionality with the turning weights. The torsions are thereby greater than in the first turning.	4. In a case of repeated magnetizations of the bar, its magnetisms approach more and more closely to a proportionality with the intensity of the magnetizing currents. The magnetisms are thereby greater than in the first magnetization.
5. By repeated application of the same twisting and untwisting weights, G. and −G. the maximum of torsion reached in the turning, sinks, and the minimum reached in the detorsion of the same, rises up to a definite limit.	5. By repeated application of the same magnetizing and demagnetizing currents, J. and −J. the maximum of magnetism reached in the magnetization, sinks, and the minimum of the same reached in the demagnetization rises up to a certain limit.
6. When twisted beyond the limits of the repeated torsions and detorsions the wire behaves as if it were twisted for the first time.	6. When magnetized beyond the limits of the repeated magnetizations and demagnetizations, the bar behaves as if it were magnetized for the first time.
7. A twisted wire which is untwisted by the force −G cannot be twisted by repeated action of the force −G in a direction opposite to the first torsion. But the force +G twists it easily in the first direction.	7. A magnetized bar which is demagnetized by a current of the intensity −J cannot be magnetized in a direction contrary to that of the first magnetization by repeated action of the current −J. But the current +J magnetizes it easily in the first direction.
8. When a wire which possesses the permanent twisting A is brought by the force *b* to the torsion B and then farther to the torsion C, which lies between A and B we need the force *b* to give it again the torsion B. In this case, A may be also 0, and B may be greater or smaller than A.	8. When a bar which has the permanent magnetism A is brought by the current *b* to the magnetism B, and then farther to the magnetism C, which lies between A and B, we need the current *b* a second time in order to communicate again the magnetism B. In this case A may also be 0, and B may be greater or smaller than A.
9. Vibrations during the action of a twisting weight increase the torsion of a wire.	9. Vibrations during the action of a magnetizing current, increase the magnetism of a bar.
10. The permanent torsion of the wire after removing the twisting weight, is on the contrary, diminished by vibrations.	10. The permanent magnetism of the bar after removing the magnetizing current is on the contrary, diminished by vibrations.

11. A wire twisted and then untwisted loses or gains torsion by vibration according to the magnitude of the detorsion.

12. The permanent torsion of iron wires diminishes by their magnetization, and that in a ratio which diminishes as the magnetism increases.

13. Repeated magnetizations in the same direction scarcely diminish the torsion of the wire. A magnetization in the opposite direction to the first produces however a new strong diminution of the torsion.

14. When a wire, by frequent magnetizations in opposite directions, is untwisted as far as possible by this process, it assumes by magnetization in one direction a maximum, by magnetization in the opposite direction a minimum of torsion.

15. A twisted wire which has been partially untwisted, loses by magnetization much less of its twist than an ordinary twisted wire. A wire farther untwisted, exhibits on feeble magnetization at first an increase of its torsion, which by augmenting the magnetization rises to a maximum and then again diminishes. The more strongly the wire was untwisted, the stronger must the magnetism be, in order to reach this maximum. When the wire is very strongly untwisted, its torsion increases, even up to the application of the strongest magnetization.

16. When a wire is magnetized while under the influence of the twisting weight, its torsion increases by weaker, diminishes by stronger magnetization.

17. A wire twisted at the ordinary temperature loses torsion by heating, and on cooling again recovers a portion of its loss. The changes increase with increasing torsion. After repeated changes of

11. A magnetised and then demagnetized bar loses or gains magnetism by vibration, according to the magnitude of the demagnetization.

12. The permanent magnetism of steel bars diminishes by their torsion and that in a ratio which diminishes as the torsion increases.

13. Repeated torsions in the same direction diminish the magnetism of a steel bar but little. A torsion in a direction opposite to the first, produces, however, a new strong diminution of the magnetism.

14. When a bar by repeated twisting and untwisting is demagnetized as far as this is possible by torsion within definite limits, it assumes a maximum of magnetism by torsion in one, and minimum by torsion in the opposite direction.

15. A magnetized bar which has been partially demagnetized, loses by torsion much less magnetism than an ordinary magnetized bar. A bar, which has been farther demagnetized, exhibits on feeble torsion, at first, an increase of magnetism which on increasing the torsion, rises to a maximum and then again diminishes. The more strongly the bar was demagnetized, the stronger must be the torsion to reach this maximum. When the bar is very strongly demagnetized the magnetization increases even up to the application of very strong torsions.

16. When a steel bar is twisted when under the influence of a magnetizing current, its magnetism increases by weaker, diminishes by stronger torsion.

17. A bar magnetized at the ordinary temperature, loses magnetism by heating, and on cooling recovers a portion of its loss. The changes are proportional to the magnetization. After repeated changes of

temperature, the wire arrives at a constant state, in which to every temperature corresponds a definite torsion of the wire, which diminishes as this temperature increases.

18. A wire twisted at the ordinary temperature, and then partially untwisted, loses on heating so much the less of its torsion, the farther it has been untwisted. Upon cooling, its torsion is less than before if the detorsion has been slight, but greater if this has been considerable.

19. A wire twisted at a higher temperature, loses torsion on cooling. Upon a second heating, it again loses, and upon a second cooling first regains a portion of its loss. When the wire is vibrated previous to the first cooling, it immediately gains in torsion.

temperature, the bar arrives at a constant state, in which to every temperature corresponds a definite magnetism of the bar, which diminishes as the temperature increases.

18. A bar magnetized at the ordinary temperature, and then partially demagnetized, loses by heating so much the less of its magnetism the farther it has been demagnetized. On cooling, its magnetism is less than before when the demagnetization has been slight, but greater when this has been considerable.

19. A bar magnetized at a higher temperature loses magnetism on cooling. By a secong heating it again loses, and by a second cooling first regains a portion of its loss. If the bar is vibrated previous to the first cooling, it immediately gains in magnetism.

From this comparison it will be seen that there is an analogy between the phenomena of magnetism and those of torsion, which holds good even in the details. The author remarks that this result is incompatible with the old assumption of the existence of magnetic fluids, but that we cannot justly infer from it, that the magnetism of a bar depends upon torsion. This is not proved by experiment; moreover as he proposes to show in another memoir, similar relations are found in the case of other molecular displacements, as for example, in flexion.—*Pogg. Ann.*, cvi, p. 161.

2. *On the densities of vapors at high temperatures.*—H. Sainte Claire Deville and Troost have continued their investigations on the densities of vapors, employing the apparatus already described, but substituting the vapor of boiling cadmium (860° C.) or of zinc (1040° C.) for the vapors of mercury and sulphur, used in their former experiments. The vessels employed were of porcelain, instead of glass, and could be hermetically sealed by means of the compound blowpipe. To avoid the difficulties of a precise determination of the temperature, the authors always employed vessels of the same substance and of the same capacity, in which they enclosed successively vapor of iodine and the vapor of the body experimented upon. In this manner, the ratio of the densities of the two vapors was determined—the density of the vapor of iodine having been previously accurately determined. By this process the determination of the temperature becomes unnecessary. The authors results were as follows:

Sulphur, at the temperature of 860° has a vapor density of 2·2, and this density does not change as the temperature rises, being the same at 1040° as determined by more than twelve experiments. We may there-

fore admit with certainty that the equivalent of sulphur (16) represents one volume of vapor, like oxygen (8).

The vapor of selenium presents the same anomalies as the vapor of sulphur. At 860° its density is 8·2; at 1040° it is not more than 6·37. The authors propose to determine the density of this substance at still higher temperatures.

The vapor density of phosphorus at 1040° is 4·5=1 vol., corresponding to the equivalent generally adopted. The vapor density of cadmium at 1040° is 3·94=2 vols. Calculated on this hypothesis it would be 3·87.

At 1040° the vapor density of sal-ammoniac is 1·01=8 vols. (calculated =0·92.) The observed vapor density of bromid of aluminum is 18·62=2 vols. (calculated =18·51).

The vapor density of iodid of aluminum in like manner corresponds to 2 vols., and is 27·0 by observation; 27·8 by calculation.

These two last numbers are calculated from experiments made in the vapor of sulphur. The iodid of aluminum exhibits a singular property indicating that its elements are united by a very feeble affinity. This iodid fuses at 125°, boils at 350°. At this temperature its vapor behaves as if it were composed of pure aluminum in a peculiar state of insulation; it burns in the air on contact with an ignited body, giving iodine and aluminum. It explodes by the electric spark when mixed with oxygen, in a strong vessel.—*Comptes Rendus*, xlix, p. 239.

3. *On organic compounds which contain metals.*—FRANKLAND has published a fourth memoir in continuation of his investigations of the compounds of metals with organic radicals. By the action of zinc-ethyl upon the iodid of stannethyl, the author obtained a crystalline compound of iodid of zinc and bi-ethyl-tin, having the formula $Sn(C_4H_5)2+ZnI$, the reaction being represented by the equation

$$SnC_4H_5I+ZnC_4H_5=(Sn(C_4H_5)2+ZnI).$$

When this compound is distilled, the distillate washed with water and again distilled, bi-ethyl-tin passes over as a clear colorless liquid, of a faint ethereal smell, and a somewhat metallic but not disagreeable taste. The density of its vapor is 8·021, which corresponds to 1 vol. of tin-vapor and 4 vols. of ethyl, the 5 being condensed to 2. It boils at 181° C. and distils over unchanged. It burns with a dark deep blue bordered flame giving off white vapors of oxyd of tin. Bi-ethyl-tin like zinc-ethyl is not capable of uniting with any other element unless an equivalent of ethyl is separated at the same time. Iodine forms with it a compound having perhaps the formula $Sn_2(C_4H_5)2I$, though it may be the compound described by Cahours and Riche, $Sn_2(C_4H_5)3I$.

By the action of methyl-zinc upon iodid of stannethyl, Frankland obtained a colorless liquid having the formula $Sn\left\{\begin{matrix}C_4H_5\\C_2H_3\end{matrix}\right.$ which he terms ethylo-methylide of tin, the vapor density of which also corresponds to 2 vols.

When zinc-ethyl is brought into contact with the iodid of methyl-mercury, $Hg\left\{\begin{matrix}C_2H_3\\I\end{matrix}\right.$, iodid of zinc is separated after a few hours, and on distillation, bi-ethyl-mercury is obtained. This body agrees completely with

the ethylide of mercury described by Buckton. Its formation may be represented by the equation

$$Hg(C_2H_3)I + 2Zn(C_4H_5) = Hg(C_4H_5)2 + Zn(C_2H_3) + ZnI.$$

This result exhibits a mobility in the atomic groups of these compounds which could scarcely have been expected.

By the action of zinc-methyl upon the chlorid of mercur-ethyl and subsequent distillation, the author obtained only a mixture of ethylide of mercury, $Hg(C_4H_5)2$, and methylide of mercury, $Hg(C_2H_3)2$, but considers it probable that in the above reaction an ethylomethylide of mercury is actually formed, but that this is subsequently decomposed by distillation.

In a previous memoir, the author showed that the vapor density of zinc-ethyl requires the formula $Zn_2\left\{\begin{matrix}C_4H_5\\C_4H_5\end{matrix}\right.$; nevertheless it was not found possible to produce the intermediate compound, $Zn_2\left\{\begin{matrix}C_4H_5\\C_2H_3\end{matrix}\right.$.

Frankland did not succeed in preparing zinc-methyl by the action of iodid of methyl upon zinc in a copper digester, although the process usually succeeds in small glass tubes. When a solution of iodid of methyl in ether is treated with zinc in the copper digester, zinc-methyl is formed in large quantity, but on distillation a body is obtained which has the formula $2Zn_2\left\{\begin{matrix}C_2H_3\\C_2H_3\end{matrix}\right. + \left.\begin{matrix}C_4H_5\\C_4H_5\end{matrix}\right\}O_2$, and which therefore appears to be a definite compound of zinc-methyl and ether. The vapor density of this liquid is 3·1215, which corresponds to 2 vols. of the vapor of zinc-methyl and 1 vol. of the vapor of ether united *without* condensation. As this result is *à priori* improbable, Frankland remarks that a mixture of zinc-methyl vapor and ether vapor in the above proportions would have the density 3·0413, without however definitely adopting either view.—*Ann. der Chemie und Pharmacie*, cxi, 44.

4. *On the isomorphism of stannic, silicic, and zirconic acids.*—The observation of MARIGNAC that the fluostannates and fluosilicates are isomorphous, renders it necessary to assume that silicic acid, like stannic acid, contains two equivalents of oxygen. G. Rose directs attention to the fact that zircon has the same crystalline form as tinstone, and agrees with this also in the cleavages. The isomorphism of zircon with one of the forms of titanic acid is still more close, although zircon has not like rutile and tinstone been found in twin crystals. The author remarks that zircon must be regarded as an isomorphous combination of one atom of zirconic and one atom of silicic acids. It appears however that there are some varieties of zircon in which the two acids are united in other ratios. Hermann has examined a zircon containing two atoms of zirconic and three of silicic acids, and has named the mineral Auerbachite; it has the same crystalline form as ordinary zircon.—*Ann. der Physik und Chemie*, cvii, 602.

5. *On the equivalent of manganese.*—The equivalent of manganese was determined by BERZELIUS as 27·56, from two analyses of the chlorid. Von Hauer has recently found for this equivalent the number 27·5 by reducing anhydrous sulphate of manganese by sulphuretted hydrogen to sulphid of manganese. His result, 27·5, was the mean of nine experi-

ments. Dumas, in his well known memoir on the equivalents of the elements, asserted that he had determined the equivalent of manganese by reducing an artificial peroxyd to protoxyd by means of a current of hydrogen, and that he had found the number 26, as he expresses it, *d'une manière absolue.* In a later communication, however, he gives the number 27·5 as the true equivalent of manganese, the same being determined by the method of Berzelius. Schneider objects to the methods of Berzelius and of von Hauer, believing that both are subject to constant sources of error. He has therefore determined the equivalent anew by the method already employed by him with cobalt and nickel, viz., by the analysis of pure neutral oxalate of manganese, the ratio between the carbon and manganese being sufficient for the purpose. In this manner four experiments closely agreeing with each other gave as the equivalent of manganese 27·019, or in round numbers 27. This result is further confirmed by the experiments of Rawack made in Schneider's laboratory, by reducing the oxyd of manganese, Mn_3O_4, in a current of dry hydrogen to protoxyd. Six experiments gave as a mean, 27·009 for the equivalent. —*Pogg. Ann.*, cvii, 605.

6. *On the equivalent of nickel.*—SCHNEIDER has furthermore revised his experiments on the equivalent of nickel, in consequence of the objection of Marignac, that the oxalate of nickel employed in his former determinations may have contained free oxalic acid. Three experiments, in which the ratio of the nickel to the carbon was determined, led as before to the equivalent 29, neglecting decimals in the second and third places.

In a third paper on equivalents and on the determination of equivalents in general, Schneider has given a very severe, but at the same time, very just criticism of Dumas' two memoirs on the atomic weights of the elements.

7. *On an easy mode of preparing metallic chromium.*—WÖHLER has given a very simple method of preparing metallic chromium by the action of zinc upon the violet chlorid. The process is as follows: one part of chlorid of chromium is mixed with two parts of chlorid of potassium and sodium, the mixture introduced into a common crucible packed tight, two parts of granulated zinc laid upon it, and covered with a layer of alkaline salt. The crucible is then heated till the mass fuses. When on removing the cover for an instant, a zinc flame is observed, accompanied by a peculiar sound, the heat is diminished by closing the draught, and the mass kept about ten minutes in fusion. The crucible is then to be removed from the fire, gently struck to collect the metal, and allowed to cool. On breaking the crucible, a well fused regulus of zinc is found under a green slag. After being well cleaned in water, it is to be placed in dilute nitric acid, which is to be frequently renewed till all the zinc is dissolved. The chromium remains as a crystalline powder, which is again to be heated with nitric acid and then well washed.

As thus prepared, chromium is a bright gray, highly crystalline powder. Under the microscope, the crystals are distinctly seen to be very sharp rhombohedrons of great lustre and almost tin-white color. Its specific gravity is 6·81 at 25° C.; it is not magnetic. Heated in the air, it oxydizes, becoming yellow and blue like steel, and gradually becomes covered with a thin layer of green oxyd. When heated in chlorine, it

glows vividly and becomes violet chlorid. Chlorhydric acid dissolves it easily to the blue protochlorid. Dilute sulphuric acid which dissolves iron easily is without action upon chromium; but on gently warming a very violent action sets in and the remaining metal now acquires the property of being easily dissolved after washing even by the most dilute sulphuric acid. Concentrated and boiling nitric acid does not attack it in the least.—*Annalen der Chemie und Pharmacie*, B. cxi, p. 230.

W. G.

II. BOTANY AND ZOOLOGY.

1. *Two new Genera of Diœcious Grasses of the United States;* by GEORGE ENGELMANN, M.D. Extr. from the *Transactions of the Academy of Natural Sciences of St. Louis, Missouri*, Vol. I, p. 431–442, with three plates, 8vo. August, 1859.—The *Buffalo-Grass*, so abundant and so widely diffused over the broad, arid region which separates our Pacific from our Atlantic possessions, is one of the humblest plants of its order, rising only a few inches above the surface of the soil; but at the same time it is one of the most important and useful, since it forms the principal subsistence of the Buffalo, for a part of the year, and no less so of the cattle of the emigrant. The botanical history of this little grass, now happily completed by Dr. Engelmann, is remarkable. Nuttall first named and described it, nearly thirty years ago; and, while he referred it to *Sesleria*, suspected it to be *sui generis*, and threw out a happy conjecture as to its natural relationship. Torrey figured it twelve years ago, and also announced its affinity to the *Chlorideæ;* he at the same time discovered its diœcious character, and showed that only the male plant was known. At length Dr. Engelmann has detected the female plant in a rather rare grass, the *Anthephora axilliflora* of Steudel, which is so unlike the common Buffalo-Grass that it naturally had been referred to a widely different tribe. Struck by the similarity of their foliage and stoloniferous growth, as they occurred together in a collection made by his brother, Dr. Engelmann shrewdly suspected the relationship, and finally set the question at rest by finding a male Buffalo-Grass which happened to bear a stalk of female flowers from the same rootstock; and these flowers were those of the so-called *Anthephora*. So different are the two that nothing short of this ocular proof would have been convincing. It hardly need be said that the male plant is not a *Sesleria*, nor the female an *Anthephora;* although they severally resemble these genera, or at least the female spikelets have a very great external resemblance to the Paniceous genus *Anthephora*. So that, Dr. Engelmann, having to characterize this new generic type, very naturally named it *Búchloë*, (as shorter and more euphonous than *Bubalóchloë*), i. e. Buffalo-Grass; and he retained the specific appellation of *Dactyloides*, although the male plant is not much like a *Dactylis*, and the female wholly unlike. Very glad we are to see the genus established under so appropriate a name,—the more so as it has narrowly escaped a different fate. That is to say, two inchoate attempts seem to have been made to found a genus upon the male sex. First, in Sir William Hooker's enumeration of the plants of Geyer's western collection, we find "*Calanthera dactyloides*, Kth.—Nutt. Sesleria, *Nutt. Gen.* v. i, p. 65." But neither Kunth nor any

other author has described a genus *Calanthera.* We have a suspicion that the "Kth." is a slip of the pen, and that the name is really Nuttall's, given by him to a specimen in the Hookerian herbarium. But if this be so, the manuscript name (which, moreover, is destitute of any particular significance) can by no means now supersede Engelmann's published one; though we might have been constrained by courtesy to adopt it, if this suspicion had occurred to him, and he had been able to confirm it. Again, in the corrections at the close of the *Plantæ Hartwegianæ*, Mr. Bentham applies the name of "*Lasiostega humilis*, Rupprecht (ined.)" to No. 250, which he had before called a *Triodia.* The plant is undoubtedly a male Buffalo-Grass. But no genus *Lasiostega* is found to be published, nor has this name any appropriateness as applied to the plant in question.

It is curious to remark that the male plant, being more proliferous by stolons than the female, has nearly displaced the latter, or has (so far as known) attained a wider geographical range as well as a far greater abundance. Probably, in accordance with a general law, the tendency to barrenness from seed which accompanies copious multiplication by offshoots, has also assisted in the production of this result,—a state of things quite contrary to the genius of that polygamous community which has effected a lodgement in the region of Buffalo-Grass.

Dr. Engelmann's second genus, *Monanthochloë*, is founded upon a singular, exceedingly stoloniferous, littoral grass, with leaves scarcely half an inch long, with solitary sessile spikelets, which has long been known to occur on the coast of Texas and Florida (collected by Berlandier, Drummond, and Blodgett), but has never been studied until now. In fact it has been thought to be something abnormal, on account of its showing as its most interesting feature, a regular transition from the foliage to the paleæ of the flowers. Dr. Engelmann notes that the glumes are wanting [perhaps represented by ordinary leaves of the axis of which the spikelet is a direct continuation], the uppermost leaf representing the lowest palea of the spikelet. The latter consists of three to five flowers, of which the lowest flower and sometimes the next are neutral or rudimentary, from one to three succeeding ones are staminiferous or pistiliferous, according to the sex, and the uppermost is also reduced to a rudiment. In the hands of agrostologists such a grass as this will be likely further to elucidate the floral structure of the order, the theory of which is by no means settled yet. Dr. Engelmann's three excellent plates, displaying all the details of the flowers, will facilitate this investigation.

The youthful Academy of Natural Sciences of St. Louis is well inaugurating its public career by publications of such character as this paper, and the more elaborate *Monograph of Cuscuta* by the same author, which is now in press. A. G.

2. *Trichomanes radicans*, Swartz.—The discovery of this Fern in Alabama by Mr. Peters and Mr. Beaumont, along with a minute new species, allied to West Indian ones, was announced in this Journal several years ago. More recently Mr. Eaton has detected indications of *T. Petersii* in West Florida, where *T. radicans*, also, will probably yet be found. We have now to state that the Rev. Dr. Curtis has discovered a locality of the latter species, during the past summer, in the Cumberland Mountains, in the eastern part of Tennessee, under the ledge of a dripping rock. Con-

trary to what would have been expected of the habitat of such a Fern, the district is very far from humid, as may be inferred from the paucity of fleshy Fungi. A. G.

3. *Thesaurus Capensis: or Illustrations of the South African Flora, being Figures and brief Descriptions of South African Plants, selected from the Dublin University Herbarium;* by WM. H. HARVEY, M.D., F.R.S., &c., Prof. Bot. Univ. Dublin, &c. Dublin, vol. I, No. 1, 1859.—The Nos. contain 25 plates each: the present one is accompanied by 16 pages of letter-press, all in octavo. The work is designed to be a running supplement and iconography of the Flora Capensis, now in preparation by its author in connexion with Dr. Sonder. It is published in quarterly parts (at 5 shillings sterling each), four to a volume of one hundred plates, with descriptions. The author is pledged to finish the first volume, and intends to continue it through five or six volumes, if encouraged by the sale of the first. As "the impression is limited to 250 copies, 150 of which are reserved for colonial sale," we cannot doubt that Prof. Harvey's moderate expectations in this respect will be satisfied. A few copies should be secured in this country,—for which Prof. Gray of Cambridge will receive subscriptions. The *profits* of the sale, *if any*, are to be devoted to the University herbarium, of which the author is the curator. The plates are very good for general habit and appearance, but the lithographic printer has not done full justice to the author's drawings on the stone. The analyses are doubtless very correct. We venture to suggest, however, that they do not always tell all that could be desired, nor does the letter-press supply the deficiency in such cases. For example take the three *Rubiaceæ* illustrated. It is not made to appear that the placentæ of the *Gardenia* are parietal, nor is the insertion of the ovules in the *Kraussia* and *Mitrastigma* made known, nor is any character mentioned to distinguish the latter from *Canthium*, to which it has been referred. A. G.

4. *Grisebach's Outlines of Systematic Botany, for Academical Instruction* (*Grundriss der Systematischen Botanik, &c.;* von A. GRISEBACH) Göttingen, 1854, pp. 180, 8vo.—A convenient manual for the class-room, and well devised for that purpose. In the classification the arrangement of the orders and the higher groups follows a new and somewhat peculiar fashion. Like all such attempts, it is happy in some associations, and very much open to criticism in others. It is enough to say that, evidently, the scientific grounds of an arrangement of the orders according to nature have not yet been discovered and applied; until they are discovered all our endeavors at shaping forth the system of nature are merely tentative; and the most that can be said of the best of them is, that it is less faulty than others. A feature in this little work which is original, so far as we know (although something much like it has been devised by Dr. Pickering), and well worthy of adoption, is the neat formula for expressing the numerical plan of the flower in an order or genus, &c., and also the degree of union or consolidation. Thus, the type of *Caryophyllaceæ* is expressed by the formula, 5, 5, 10, $\widehat{3}$. These numbers represent the number of parts in the several floral organs, beginning at the left with the sepals; the second figure represents the petals; the next the stamens; the last the pistil. The curved line over the latter indicates

the union of the three carpels into a compound pistil. Take now for example, a few of the genera:

Silene, $\widehat{5}$, 5, 10, $\widehat{3}$. *Dianthus*, $\widehat{5}$, 5, 10, $\widehat{2}$.

Cerastium, $\widehat{5}$, 5, 10, $\widehat{5}$. *Sagina*, $\widehat{4}$–$\widehat{5}$, 4–5, 4–5—8–10, $\widehat{4}$–$\widehat{5}$.

Corrigida, $\underbrace{\widehat{5}, 5}$, 5, $\widehat{3}$. *Scleranthus*, $\underbrace{\widehat{5}, 0, 10}$, $\widehat{2}$.

The 0 expresses the absence of that part of a complete flower. While the curved line above indicates *connation*, or union of the several parts of a whorl, the bracketed lines underneath express *adnation*, the union of the parts of successive cycles. The character ∞ stands for an indefinite number, as used by DeCandolle. So the formula for *Malvaceæ* is $\widehat{5}$, 5, $\widehat{\infty}$, $\widehat{\infty}$.

For *Hypericineæ*, $\widehat{5}$, 5, $\widehat{3\infty}$—$\widehat{5\infty}$, $\widehat{5}$. *Rosaceæ*, $\underbrace{\widehat{5}, 5, \infty}$, ∞.

Commelynaceæ, 3, 3, 6, $\widehat{3}$. *Irideæ*, $\underbrace{3, 3, 3, \widehat{3}}$.

Gentianeæ, $\widehat{5}$, $\underbrace{\widehat{5}, 5}$, $\widehat{2}$. *Scrophularineæ*, $\widehat{2:3}$, $\widehat{3–2}$, 2 : 2, $\widehat{2}$.

Rubiaceæ, $\underbrace{\widehat{5}, \underbrace{\widehat{5}, 5}, \widehat{2}}$.

The botanist will perceive the whole plan at a glance. It is equally applicable to the genera; a word or two in addition expressing the nature of the fruit, or any peculiarity of structure. A. G.

5. *Structure and growth of Rootlets.*—According to the Gardener's Chronicle, Prof. Henfrey has published an interesting paper, in the Journal of the Royal Agricultural Society, on the structure of roots. The points which are spoken of as novel and practically important are—1, that "the growing point of a root is not at its absolute extremity, which is covered by a cap-shaped or hood-like portion of epidermis of its own, continuous likewise behind with the cambial structure. This cap-like sheath of the point of the root may be compared with the head of an arrow, forming a firm body, which can be pushed forward by the growing force behind to penetrate through the resisting soil .... When it undergoes decomposition in proportion as it is renewed behind, it presents an irregular ragged appearance, which probably gave rise to the idea of a spongy structure at the ends of the rootlets:" i. e. the spongioles of DeCandolle. 2. That in *many* cases there are present upon the young root infinite multitudes of little hairs, through which food is imbibed, and by which the absorbing power of the surface of the root "is considerably augmented." However it may be in England, these are both matters of elementary knowledge in the United States, and have been for the past ten years.—In the Annales des Sciences Naturelles for 1858, published in 1859, Garreau and Brauwers have an article upon the same subject, bringing out essentially the same familiar facts. They, however, direct attention principally to the continued exfoliation of these root-points, by which, in some cases, considerable organic matter is thrown off into the soil,—offering an explanation of the excretion from the roots, of which much account was formerly taken by Marcet and DeCandolle.

Since the above was written we have learned with sorrow the death of *Professor Henfrey.* In the announcement, the editor of the Gardener's Chronicle appropriately remarks, that "Professor Henfrey has long been known as an excellent histologist and sound vegetable physiologist. Especially conversant with the botanical literature of the Germans, it has been to his pen that we owe many valuable dissertations upon subjects little attended to in England. The papers in the Micrographic Dictionary of his friend, Dr. Griffith, are justly celebrated for their accuracy as well as skillful condensation. The physiological part of his Elementary Course of Botany, and the papers on Vegetable Structure now in course of publication in the Journal of the Royal Agricultural Society will always be regarded as the productions of one who was not only familiar with the truths of science, but able to render them attractive to those who are little accustomed to think upon such subjects." Probably his best original contribution to science was his investigation into the formation of the embryo in *Santalum.* A. G.

6. *Some plants take arsenic with impunity.*—That vegetables are killed by watering with an aqueous solution of arsenic was long ago shown by Marcet, Jäger, Link, &c., and also by experiments made in this vicinity within the present year. Still, moulds will grow in paste poisoned with arsenic, and some insects will feed upon animal matter impregnated with arsenic without apparent injury.* Notwithstanding these known exceptional cases, however, the following statements, condensed from the Gardener's Chronicle for Sept. 10, are startling, not only in a physiological point of view, but because, if confirmed, they must affect all medico-legal evidence in cases of suspected poisoning. Dr. Edmund Davy, Professor of Agriculture and Agricultural Chemistry in the Royal Dublin Society, knowing that sulphuric acid containing arsenic was largely employed in making superphosphate and other artificial manures, and that these must therefore contain variable quantities of that substance, conceived it probable that plants supplied with such manures might imbibe some arsenic, and in this way be rendered more or less unwholesome as articles of food. To ascertain, in the first instance, whether plants really take up arsenic when presented to their roots in the soil, Dr. Davy transplanted into a flower-pot three small plants of peas, and when they were established, he commenced watering them every second or third day with a saturated aqueous solution of arsenious acid; and *this treatment was continued for more than a week without its appearing to produce any injurious effects upon the plants.* At this period Dr. Davy was obliged to leave home for some months; on his return he found that these plants had grown up to their full size, had flowered and fruited. On chemical examination he detected arsenic in them, both in the herbage and the seeds. Having thus learned "that arsenic might be taken up in considerable quantity by plants without destroying their vitality, or appearing even to interfere with their proper functions," Dr. Davy proceeded to ascertain whether arsenic as it existed in different artificial manures (such as the superphosphate) would in like manner be taken up by plants growing where these manures had been applied. He tried the experiments with cabbage-plants in a soil consisting of one part of superphosphate to four of garden mould. When a plant had *grown healthily in this soil for three*

* See this vol., p. 166.

weeks (where, the wonder is, that it should have grown at all, irrespective of the arsenic), he cut off its top, tested it for arsenic, and found "the most distinct indications of the presence of that substance." Finally, to ascertain if arsenic could be detected in crops grown with superphosphate in the ordinary way and amount, he took turnips from fields in which this manure had been used, and obtained from them "the most unmistakeable evidence of having been arseniated." The facts thus collected appear to Dr. Davy "to have some important bearings; for though the quantity of arsenic which occurs in such manures is not large when compared with their other constituents, and the proportion of that substance which is thus added to the soil must be small, still plants may during their growth, as in the case of alkaline and earthy salts, take up a considerable quantity of this substance, though its proportion in the soil may be very small. Further, as arsenic is well known to be an accumulative poison, by the continued use of vegetables containing even a minute proportion of arsenic, that substance may collect in the system till its amount may exercise an injurious effect on the health of men and animals." Dr. Davy's paper is published in the London, Dublin, and Edinburgh Philosophical Magazine, Aug. 1859, p. 108. A. G.

7. *Death of Mr. Nuttall.*—We learn that this veteran naturalist,—whose health has for several years been much impaired,—died on the 10th of September last, at his residence, Nutgrove, near Preston in Lancashire, at the age of seventy-three. In view of the great services which Mr. Nuttall has rendered to the botany, ornithology, and mineralogy of the United States during the last forty years, a fitting tribute to his memory may be expected from the hands of some of his surviving friends.

The death of *Dr. Horsefield* is also announced, at the age of 86 years. While Mr. Nuttall, born in England, passed the active portion of his life in the United States, Dr. Horsfield, born in Pennsylvania, made his scientific collections in Java, under the East India Company, in whose service, at the India House, he continued down nearly to the close of his long and honorable life. A. G.

ZOOLOGICAL NOTICES.—

8. *Bidrag till Spitsbergens Molluskfauna: jemte en allman öfversigt af Artiska Regionens, naturförhallanden och forntida utbredning*, af OTTO TORELL. Part I, 8vo, pp. 154 and 2 plates. Stockholm, 1859.—A work of much interest to naturalists and others who have directed their researches to the Arctic regions. The first part commences with a historical and geographical account of Spitzbergen, with geological notices, chiefly of glacial phenomena, and a comparison of the fauna of the island with that of neighboring countries for the advancement of our knowledge of geographical distribution. A table is given showing the distribution of 160 species of birds around the Arctic circle. But in this table he makes many species common to the two continents which are not so in reality, as has been recently determined by Baird and Cassin. In the systematic account of the Spitzbergen mollusca this Part reaches only to *Arca* among the bivalves. The synonymy is well elaborated, and the errors of Middendorff and others in that of the *Crenellæ* are exposed.

The following instances will show the opinion of the author with regard to the synonymy of species also found on the New England coast. *Modiola nexa*, Gould, is *Crenella nigra*. *Mytilus levigatus* (*discrepans*

Gould) is *C. substriata* (Gr.). *Nucula tenuis* of Gould is *N. expansa* Reeve, and not the *tenuis* of Europe. *Leda tenuisulcata* of Stimpson is *L. pernula*. *Leda sapotilla* is *L. hyperborea* Lovén (?) One new genus is described, *Dacrydium*, for a shell which is supposed to be the *Modiola vitrea* of Möller. It differs from it in its "dentes crenulati, antico tuberculiformi, postico elongato, cristis suffulti decurrentibus," etc. The occurrence of an *Arca* (*A. glacialis*) in so high a latitude is noteworthy.

W. S.

9. *Videnskabelige Meddelelser fra den naturhistoriske Forening i Kjöbenhavn for Aaret* 1858. With 2 plates. Copenhagen, 1859.—This number contains the following articles:—Plantæ Centroamericanæ; *A. S. Oersted.* Ad Bryologiam Norvegicam annotationes aliquot; *Th. Jensen.* Some remarks on the northern species of the genus *Aega*, and on the proper limits of the genus; *C. Lütken.* On Stegophilus insidiosus, a new fish from Brazil, and on its habits; *J. Reinhardt.* Description of a new species of Serolis, S. Schythei; *C. Lütken.* Annulata Oerstediana, etc.: Enumeration of the Annelides collected by Oersted and Kroyer in the West Indies and Central America; *E. Grube.* Description of the "Gallernosen" at Lolland; *Kostrup.* Supplement to my conspectus of the Danish Echinodermata and to my catalogue of the West Indian and Central American serpent-stars; *C. Lütken.* Winter-flora of Nice; *C. Vaupell.* On the dwelling of the true *Cymothoæ* in the mouths of various fishes; *C. Lütken.* Proceedings of the scientific meetings of the Natural History Society in the year 1858. W. S.

10. *Bidrag till Kännedomen om Skandinaviens Amphipoda Gammaridea af* R. M. BRUZELIUS. (Kong. Vet. Akad. Handl. 1858,) pp. 104 and 4 plates.—A most valuable contribution to our knowledge of that difficult order the Amphipoda. 77 species are described, of which 18 are new. The new genera are *Lætruatophilus* (fam. Dulichidæ), *Autonoe* (fam. Corophidæ), *Eriopis* (fam. Gammaridæ), *Paramphithoe*, for *Amph. panopla*, *hystrix*, *bicuspis*, etc., (why reject *Amphithonotus* Costa,) and *Nicippe*, near *Pardalisca.* Nineteen species are figured. The descriptions in Swedish are very elaborate, and a Latin character is given for each species. W. S.

III. ASTRONOMY.

1. *Supposed planet between Mercury and the Sun.*—At a session of the French Academy of Sciences, Sept. 12, 1859, a paper by M. LeVerrier was read, giving the result of his researches undertaken in order to ascertain the cause of the discrepancies between the places of Mercury as determined by observation of its transits across the sun and as required by theory. He finds that by adding 38 seconds to the secular motion of the perihelion of Mercury, these observations will be represented within about one second. The cause of this disturbance he presumes to be either one planet or a group of small planets within the orbit of Mercury; and calls on observers to watch the sun's disc in order to detect the transit and also during total solar eclipses to scrutinize the vicinity of the sun.

NOTE.—In this connection it may be worth while to state that there are already on record observations which make it highly probable that there exists an intra-Mercurial planet with a satellite. Wartmann reports

(*Bibl. Univ.* Avr. 1837, p. 409; *Quetelet: Corr. Math. et Phys.*, Aug. 1837, p. 141) that Pastorff, of Buchholz, an attentive observer of the solar spots, saw twice in 1836 and once in 1837 two round black spots of unequal size, moving across the sun, changing their place rapidly, and pursuing each time routes somewhat different. He found that the two bodies observed Oct. 18, 1836, traversed an arc of 12′ from $2^h\ 20^m$ to $3^h\ 12^m$; that the two observed Nov. 1, from $2^h\ 48^m$ to $3^h\ 42^m$ traversed in this time an arc of 6′, and that the two observed Feb. 16, 1837, traversed an arc of 14′, between $3^h\ 40^m$ and $4^h\ 10^m$. In 1834 Pastorff saw two similar bodies pass six times across the disc of the sun. (*Bib. Univ.*, t. 58.) The larger was about 3″ in diameter and the smaller 1″ or 1″·25. Both appeared perfectly round: sometimes the smaller preceded the larger, sometimes the contrary. The greatest observed distance between them was 1′ 16″. The bodies were often very near each other and their transit then occupied only a few hours. They had the appearance of a dull black spot, like that of Mercury in its transits.

On further search the following statements were found, which may perhaps bear on the case. Flaugergues mentions (*De Zach: Corresp. Astron.*, vol. 13, p. 17, 1825) that Pastorff saw *two* remarkable spots on the sun Oct. 23, 1822, and also spots July 24 and 25, 1823. Olbers (in *Tilloch's Phil. Mag.*, vol. 57, p. 444, 1821) cites Gruithuisen's observations of three solar spots June 26, 1819, viz., one near the middle of the sun, and *two small ones without nebulosity* near the western limb.

M. LeVerrier's new Tables seemed, (by the Report made to the French Academy, Aug. 4, 1845, C. R. 21 : 316,) to show that Mercury suffered no unexplained disturbance. Nevertheless, in the hope of finding this presumed planet I undertook in the year 1847, in conjunction with Mr. Francis Bradley, to observe the sun's disk twice a day when practicable, and also to explore the neighborhood of the sun with a telescope armed in front with a long pasteboard tube blackened inside. These efforts, made with an instrument badly mounted, in an inconvenient place, proved fruitless, and were finally given up on account of the pressure of other work. Such observations ought to be resumed by those who can command suitable means. The fact that for twenty years past no such bodies as those seen by Pastorff have been detected by the numerous observers of solar spots may perhaps be due to the large inclination of the planet's orbit.

E. C. HERRICK.

2. *Shooting Stars of August* 9–10, 1859.—The following observations by Prof. A. C. Twining at Boston, Mass., and by Mr. Francis Bradley and others at Chicago, Ill., show that the usual meteoric display of August 9–10 occurred this year, but on a scale somewhat reduced. E. C. H.

(1.) *Observations at Boston, Mass., by Prof. Twining.*—"From $2^h\ 15^m$ A. M. to $3^h\ 30^m$ (10th) I observed 45 conformable and 11 unconformable meteors in a space around the radiant whose radius would be about the arc from the Pole to *α Tauri*. The sky clear; paths of meteors not long nor brilliant; two left visible traces for about six seconds. The average place of the radiant during the time of observation was near 38° 30′ A. R. and 57° 15′ N. decl."

(2.) *Observations at Chicago, Ill., by Mr. Francis Bradley and others.*—July 29, 1859, 10½ to 11½ P. M.—watching alone, looking chiefly to the northeast, Mr. B. observed in the hour *sixteen* shooting stars, of which

five or six only were conformable to the August point of radiation. Aug. 5, 11 to 12 P. M.—*nineteen* shooting stars were observed during the hour, seven or eight of which were conformable.

Aug. 9. Observers—Messrs. F. Bradley, Wm. Dickinson, E. P. Marsh, and after 1 of the 10th, Mr. L. Baird. The sky was nearly clear, and the moon interfered until about one o'clock.

Shooting stars observed:

11 to 12 P. M.,	in N.	12	
" "	" W.	7	
" "	" E.	6	25
12 to 1 A. M., (10th,)	" N.	12	
" "	" W.	13	
" "	" E.	14	39
1 to 3 A. M.	" N.	54	
" "	" E.	33	
" "	" S.	61	
" "	" W.	78	226
3 to 3½ P. M.,	" N.	24	
" "	" E.	10	
" "	" S.	22	
" "	" W.	22	78

The meteors were plainly increasing in frequency during the latter part of the time. Few of them were large, and only a small number of all were unconformable to the point of apparent radiation usual at this date.

IV. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Earthquakes in California during* 1858; by J. B. TRASK, M.D.—During the past year we have had occasion to note the occurrence of eight shocks of earthquake in this State. This number is one half less than that in 1857, and one third less the number in 1856. The shocks with one exception have been unmarked by anything like violence, being little else than mere vibrations or tremors unnoticeable by the great majority of the people. They are as follows:

Feb. 10th.—A smart shock at Kanaka Flat, Sierra Co. No time noted.

Feb. 15th.—A light shock in San Francisco at 4^h 20^m. Was observed in the county of San Mateo ten miles south of the city.

Aug. 19th.—A light shock in San Francisco at 22^h 10^m. The motion was east and west and undulatory.

Sept. 2nd.—A smart shock at Santa Barbara, no time given.

Sept. 3rd.—A smart shock in San Jose at 0^h 40^m. This shock was felt at Santa Cruz 25 miles west, and was evidently more marked in strength at that locality. No damage.

Sept. 12th.—A smart shock at San Francisco at 19^h 40^m. The motion was from north to south. There were two vibrations with undulatory movements lasting about fifteen seconds.

Sept. 26th.—A light shock at San Francisco at 1^h 26^m.

Nov. 26th.—A heavy shock at San Francisco at 0^h 34^m. This shock was by far the heaviest during the year, it awoke most people from slumber and created no little alarm, persons left their beds and sought cooler

situations with less attire than is usually worn. The iron pillars in the second story of the custom house have separated from the ceiling above about half an inch, and are supposed to have settled from the effects of the shock: I much doubt the alleged cause of this displacement, as the pillars below present no indications of similar disturbance. This shock was felt at Oakland ten miles east of the city, but was not felt at Stockton, Sacramento, or Marysville. It was evidently confined to an area of ten or twelve miles.

Up to this date, (Aug. 10th, 1859,) there have been but three shocks during the present year.

2. *Eruption of Mount Hood.* (Extract from a private letter dated San Francisco, Sept. 4th, 1859).—"On the 15th, 16th and 17th of August, 1859, the atmosphere at this place (Portland, Oregon,) began to grow quite sultry, on the 17th the air very soon after ten o'clock became exceedingly hot, a very unusual circumstance here. The sky up to noon was nearly cloudless, but after meridian the heavens assumed an unusual aspect; on directing our attention toward Mt. Hood we all observed a most singular collection of clouds hovering over the summit, having a light silvery aspect, mingled with others of darker hue, heavy and apparently lowering. Up to the close of the following day nothing else unusual had occurred, the clouds still hanging over the mountain. On the evening of the 18th flashes of light were frequent from about the summit, and a full volume of illuminated vapor at times would ascend. On the 19th and 20th heavy volumes of cloudy vapor continually poured out from the crater, and on the evenings of these days the shafts of flame were almost constant, the light was continuous through the night. On the 20th the smoke cleared up for a short time affording a view of the summit, it was observed to have changed its aspect to the naked eye, but with glasses the upper northwest side of the summit had disappeared entirely, it had the appearance of an immense gap, the presumption is that it has fallen in. There are parties on their way to the mountain to explore it, and on their return I will write you again."

3. *Improved mode of preparing Diatomaceæ;* by CHRISTOPHER JOHNSTON, M.D. (In a letter to the editors dated Baltimore, Md., Sept. 14th, 1859.)—Allow me to offer an improvement in the preparation of guano, diatomaceous earth, &c., for mounting either dry or in balsam. It consists in the substitution of chlorate of soda for the chlorate of potash employed according to Bailey's method; and the whole process may be thus summed up. 1. (Say for guano) wash in water. 2. Boil in nitric acid. 3. Pour off the acid from the sediment, add fresh acid, boil for fifteen minutes, pour in a little muriatic acid and boil for five minutes. 4. After complete washing out of the acids, carbonize the residue with strong sulphuric acid; effect the combustion of the carbonized portion with *chlorate of soda;* wash perfectly with water, and the diatoms need no further treatment.

Two things are gained by this method; 1st. Sulphate of soda is very soluble and may easily be removed by washing—this is not the case with sulphate of potash. 2d. It renders unnecessary a new boiling in acid of the residual sand, diatoms, &c., as recently proposed by a distinguished practical microscopist of this country for the perfect removal or destruction of sulphate of potash remaining *in* or about the diatoms. Protracted

boiling in strong acids injure the valves of diatoms, and especially those which have delicate markings; Bailey's method as modified by your subscriber subjects them to the least possible risk of being broken or defaced.

4. *Proposition for a Humboldt Fund for Scientific Investigations and Travels.*—[We have received from the venerable and distinguished Carl Ritter,* the illustrious Geographer of Berlin, the following "Proposition," and take pleasure in laying it before the American public in the hope that the appeal which it impliedly contains for American contributions may not be in vain. We shall be very happy to receive and transmit to Berlin any contributions to the HUMBOLDT FUND which the friends of science may entrust to us.—EDS.]

"In the course of centuries there springs up here and there a man who, uniting powers of investigation and generalization, like Aristotle or Leibnitz, represents in himself the multifarious science of his time. Among these few powerful minds belongs ALEXANDER VON HUMBOLDT; bold and cautious, profound and comprehensive, alike fertile and brilliant, a pride and a joy to his contemporaries of both hemispheres. What he brought to life in science will never die, but will continue bearing fruit by its own inherent power. But his place in the world is left vacant, and that prompt and helpful love, that unwearied and fostering zeal which the struggling scientific talent of every land found in him are departed. No one can render aid productive of such results as that rendered to science by Alexander von Humboldt. Nevertheless it is a natural wish to perpetuate beyond his life through an Institution, this noble department of his activity.

"It is therefore proposed to found an institution under the name of the *Humboldt-Stiftung*, having for its object to afford assistance to rising talent, wherever it may be found, in those directions to which Humboldt devoted his scientific energies, viz., scientific labors, and extensive journeys of exploration.

"It is proposed to confide the distribution of any means obtained for this purpose to the scientific body of which he has been a faithful and efficient member for sixty years, and which only a few weeks before his death listened to his animating voice, viz., the Royal Acad. of Sciences at Berlin.

"This body upon the proposal being made, has declared itself ready to draft and in conjunction with the Committee to establish the statutes of the Association, adapted to the amount of capital subscribed, and to apply its resources worthily in assisting promising or already developed talent. In pursuing such an aim we recognize the hindrances which arise from the circumstances of this particular period. But we do not shrink in these excited days of war from quietly carrying forward the everlasting mission of peace entrusted to science, which binds all nations in one.

"It is due to the memory of Alexander von Humboldt, and it seems to us no impracticable thought, to unite in one efficient body the Princes who honored him, the members of that Nobility to which he by birth belonged, the scientific litterateurs who admired him, learned men who were enchained by his cosmopolitan spirit, the circle of trade who profited by his discoveries, the prominent persons in cultivated European circles where he worked, as well as in other lands of both worlds—to unite them all so as to form a living monument to his name, which shall work on for science from age to age.

* Whose demise we have to lament since writing these lines.—See p. 451.

"In this feeling we take the liberty of inviting a collection for the Humboldt-Stiftung, and beg that subscriptions may be sent to the banking house of Mendelsshon & Co., in Berlin. The collected capital will be invested with prudence and the interest applied to the specified objects. In six months a report will be rendered to the public.

"We recommend then in full confidence to the active friendship of all who recognize in truth and gratitude the greatness of the departed, an institution which will work down to remote ages in Humboldt's spirit, and do honor to his name."

[This memorial is signed by F. v. Bunsen, Ehrenberg, Dove, Encke, Lepsius, Magnus, Ritter, and sixteen others.]

5. *The 29th Meeting of the British Association for the Advancement of Science* was held at Aberdeen, Scotland, commencing on the 14th of September.—It was graced by the presence and the hospitality of Royalty. The Prince Consort made a very sensible opening speech, and the meeting appears to have been in all respects a good one.

6. PROF. J. D. DANA sailed for Europe in October, for an absence of about a year. Rest from his too severe and long continued scientific labors which had begun to tell upon his health, was the leading motive of his journey. He spends the winter in southern Italy.

7. PROF. AGASSIZ returned in September from his late visit to Switzerland refreshed in health and spirits, and laden with treasures for the new museum at Cambridge, the building for which we learn is rapidly approaching completion.

8. *Government Scientific Expedition in New Mexico.*—In our notice of Dr. NEWBERRY's *New Mexican Explorations* on page 298 of this volume, we inadvertently neglected to say that Dr. Newberry is connected with a government expedition under the War Department, commanded by Capt. McComb of the U. S. Army, under whose direction the investigations are being made.

9. *Journal of the American Oriental Society.* Vol. vi, No. 1.—This Society, in its zealous cultivation of oriental literature, has just now been placing the scientific world under special obligations. Two important papers, revealing to the English reader some of the treasures of Oriental science, occupy nearly the entire number of the Journal now before us, the annual half volume for the current year.

The first is an article of 128 pages by the Chevalier N. Khanikoff, Russian Consul-General at Tabrîz, Persia. It consists of an analysis and extracts of an Arabic work on the water-balance, written by 'al-Khâzinî in the twelfth century, and entitled *Book of the Balance of Wisdom.* This paper, originally in French, the Committee of Publication have here presented in English, with a translation *de novo* of the extended extracts from the original work, which are here printed in Arabic, in connection with the portions of the article to which they belong. The committee have also appended a large body of critical and explanatory notes.

The Balance of Wisdom or Water-Balance, is a balance for determining specific gravities; and the Arabic work here analyzed and translated is a systematic treatise on the subject, containing descriptions in detail, with figures of several ingenious forms of such balances; also expositions of the philosophical and mechanical principles involved in their construction and use, together with experimental results. It is a curious and very instructive monument of the state of experimental philosophy among the Arabs, at a time when they became almost the sole custodians of the

science of the world; the treasures which they had obtained by conquest from Greece and India being faithfully kept by them during the long eclipse of European learning until the western nations, emerging from the darkness, were ready to receive them at their hands, and under the influence of a higher civilization develop the germs thus providentially preserved into the rich fruits of modern science.

We quote a few specimens of the results for specific gravities given in the "Book of the Balance of Wisdom," in connection with modern determinations.

Substances.	acc. to 'al-Khâzinî.	Modern authorities.
Gold,	19·05	19·26–19·3
Mercury,	13·56	13·56–13·59
Lead,	11·32	11·35–11·44
Silver,	10·30	10·43–10·47
Copper,	8·66	8·67– 8·85
Brass,	8·57	8·40– 8·60
Iron,	7·74	7·6 – 7·79
Tin,	7·32	7·29
Emerald,	2·75	2·68– 2·77
Pearl,	2·60	2·61– 2·75
Salt,	2·19	2·07– 2·17
Wax,	0·95	0·96
Boiling Water,	0·958	0·960
Ice,	0·965	0·916–0·927
Sea Water,	1·041	1·029–1·04
Olive oil,	0·920	0·918–0·919
Human blood,	1·033	1·053

The other article referred to, filling 128 pages, is the first part of a translation from the Sanskrit of one of the oldest and most important text-books of Hindu astronomy, the Sûrya-Siddhânta, with notes and an appendix, by Rev. Ebenezer Burgess, formerly missionary of the A. B. C. F. M. in India, assisted by the Committee of Publication.

We only call attention to this very interesting paper at the present time, as it will deserve a more extended notice when completed. The original work is composed, like most of the Sanskrit literature, in metrical stanzas of two lines each, and its concise and peculiar forms of statement would to a great extent, be unintelligible even when translated, without the full and scholarly commentary which has been supplied by the several editors. This commentary, which is largely indebted for its value to the sound oriental scholarship of Prof. Whitney, and to the mathematical supervision of Prof. Newton, of Yale College, is adapted to the wants of two distinct classes of readers,—those who are orientalists without being astronomers, and those who are astronomers without being orientalists; thus rendering this important exposition of Oriental Astronomy attractive to all those who would learn more distinctly how much the world is indebted to the Hindu mind for so many of the elements of scientific, as well as of general, knowledge.

10. Obituary.—Prof. Carl Ritter the distinguished Geographer, died at Berlin, Sept. 28th, in his 81st year. He was born August 8th, 1779.

Death of Dr. Grailich.—We are pained to record the early death of Dr. Joseph Grailich the distinguished crystallographer and physicist. At the time of his decease Dr. Grailich was Professor of mathematical physics in the Imperial University at Vienna and one of the Adjunct Curators of the Imperial Mineral Cabinet. He died at Vienna on the 13th of September in the 31st year of his age.

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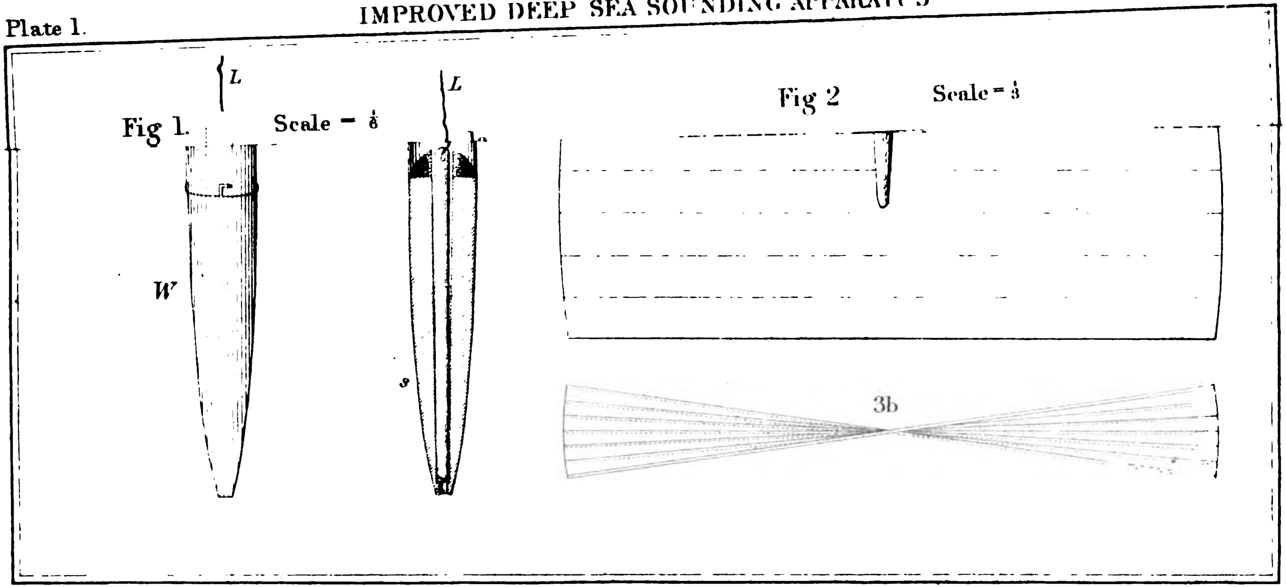
Plate 1.

IMPROVED DEEP SEA SOUNDING APPARATUS



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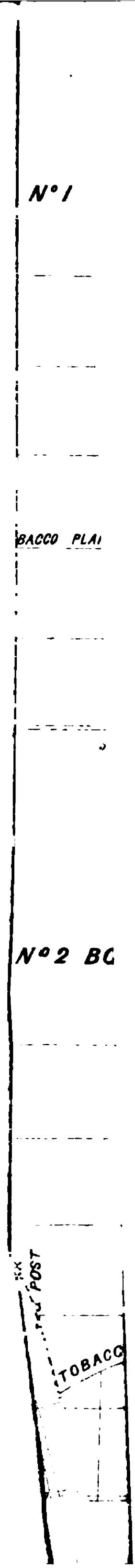
Eng

Eng[d] by R. F. Bartle


N° 1
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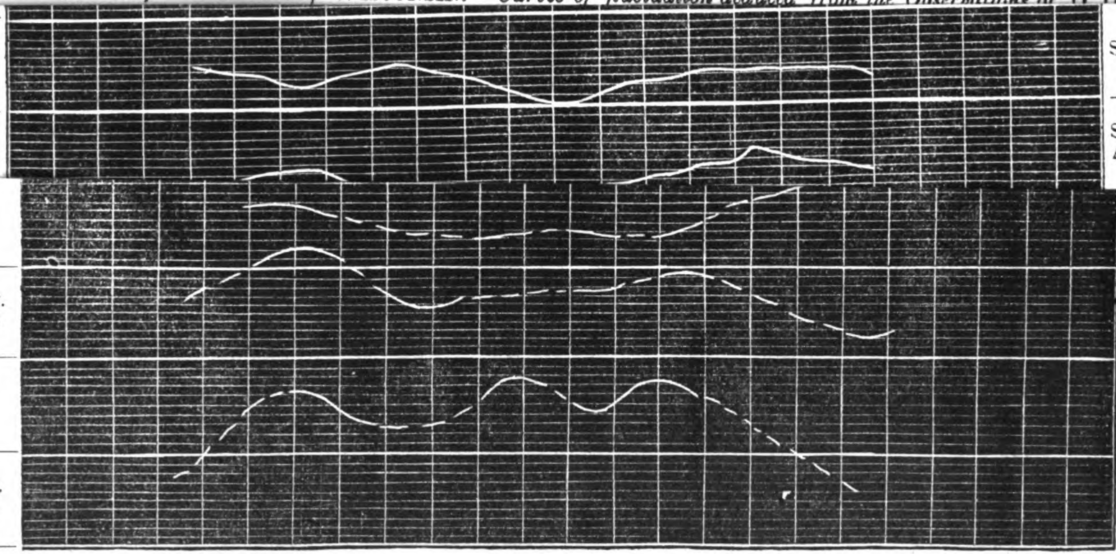
WATER LEVELS, GREEN BAY, WISCONSIN.—*Curves of fluctuation deduced from the Observations of D. Underwood, Esq.*



" 3d. 9 A. M.	A. M. 8 26	South 2 to 4; cloudy.
" 4th. 5 P. M.	A. M. 9 26	Southwest 1 to 2; A. M., cloudy. Afternoon, clear.
" 23d. 7 P. M.		Southwest, 1; cloudy.
" 24th. 3 A. M.	A. M. 0 38	Northeast gale at half past 12 A. M. to 3 A. M.; N. E. 4½—7 A. M. 4—7 P. M. calm.
		Northeast gale Oct. 31 P. M. to afternoon of Nov. 2d. Conjunction, Nov. 5th.
Nov. 2d. 2 P. M.	A. M. 9 24	At Oconto River the water fell 1[illegible] inches with the wind still north east.

NOTE.—Thermometer read at 5 A. M.—Lowest water of the season, Oct. 16, 2 P. M., being 24½ inches, B, wind S. 3.—Highest, Nov. 2d, 2 P. M., 15 inches, A, wind N. E., a gale.—Difference 39½ inches.—April 17, 1848, 23 inches, A.